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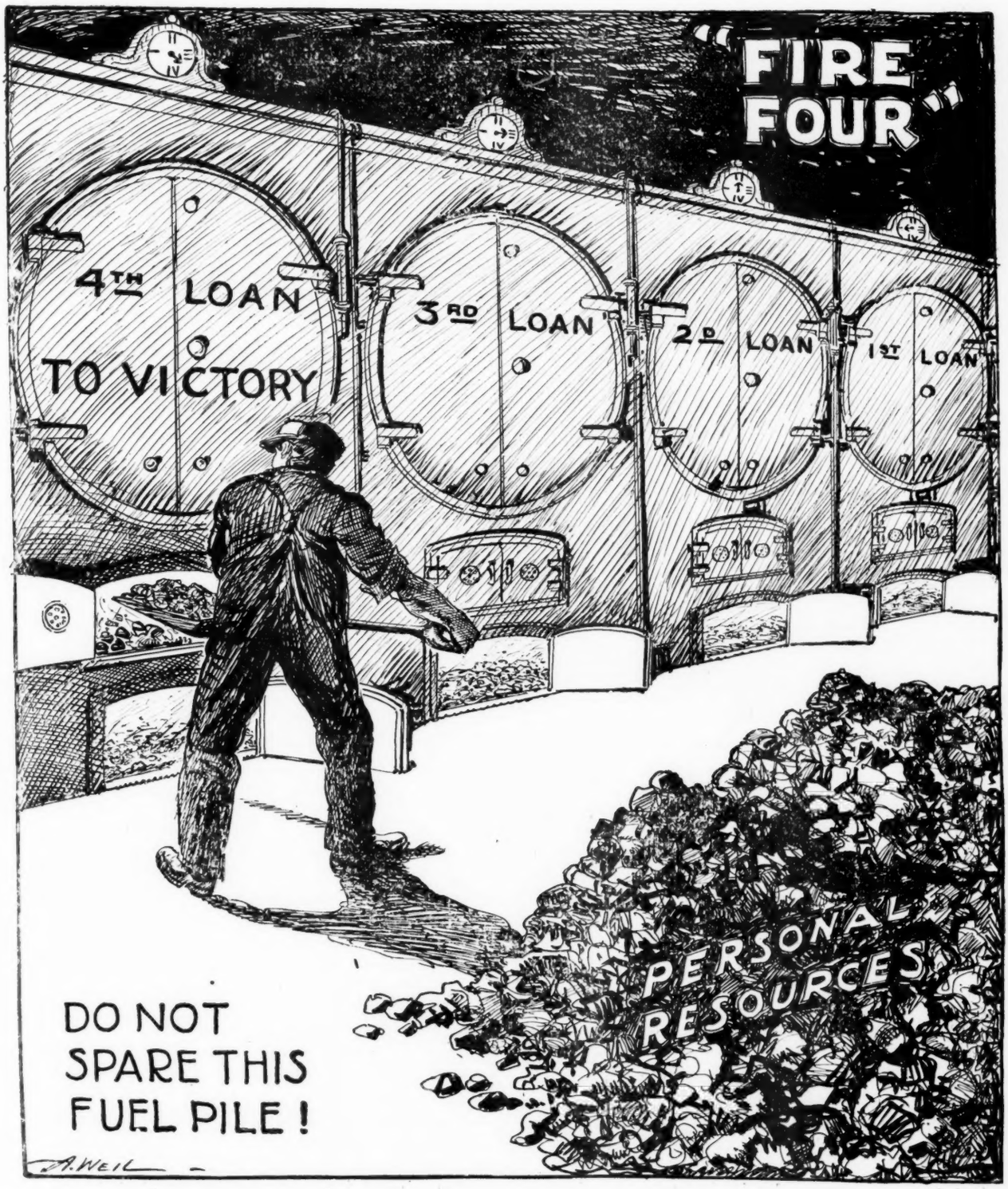


Steam-Boiler Regulation and Control

By ALBERT A. STRAUB

That the proper handling of the damper for controlling the draft for steam-boiler furnaces is of importance is brought out in this article. Charts showing the variation in the temperature of gases escaping from the boiler and of the steam pressure are shown, each indicating a condition of damper contact.

THERE is probably no more vital factor influencing the economical operation of steam-boiler installations, whether coal-, gas- or oil-fired, than the proper regulation of the damper to suit the furnace and load condition. The general tendency and almost universal practice among firemen is to regulate the steam pressure by the use of excess air rather than by the use of the damper. The firemen are, however, hardly to be held accountable in the majority of installations for the failure to use the damper, as the methods of control, or rather noncontrol, provided tend to obscure the fact that dampers are installed rather than to encourage their use. The fact that the damper can be used to advantage when the boilers are banked, to keep cold air from passing through the setting, to maintain a nucleus of incandescent fuel to aid in starting up the boilers and to reduce the amount of coal required to raise the steam pressure, appears to be overlooked in most plants, many of which are of no mean size.

In order to secure proper manipulation of the damper, a simple and easily operated means of control should be provided, accessible to firemen and so situated that a draft gage is in plain view to guide the firemen in the operation of the damper.

One of the cardinal rules in firing steam boilers is to regulate the steam pressure and the condition of the fire by the damper. This rule will apply whether the installation is hand- or stoker-fired in order to secure the best economy of operation. To properly burn a given quantity of coal a certain amount of air is required; supplying more or less air than is required will not establish the necessary condition to obtain proper combustion and will therefore have a negative effect and decrease the efficiency. This condition is usually brought about by neglect to use the damper to control the fire.

In plants operating under variable load, the best practice is to keep in operation as nearly as possible all the boilers that will be required to carry the maximum load with a certain degree of safety. The usual method of operation during low-load periods is to keep the dampers wide open and the grates partly covered with fuel when the steam pressure is normal, with corresponding use of large quantities of excess air. When the steam pressure starts to fall, fuel is usually quickly shoveled into or mechanically supplied to the furnace, with a corresponding decrease in the quantity of excess air entering the furnace and an increase in steam pressure. Firemen are not altogether at fault for using this method of operation, but are often encouraged therein by plant managers, who seem to be unwittingly bent on seeing a fine quality of refuse dumped from the furnace at their own expense, being entirely unconscious of the heat wasted up the stack by heating excess air, which loss is not so visible to the eye as is coke in the refuse, but is just as deadly to the coal pile. There is a middle ground, or economic point, for loss to the stack and loss to the ashpit, for each particular type of installation and fuel used, beyond which point the saving in stack loss or ashpit loss cannot be carried without too great a corresponding loss on the related factor.

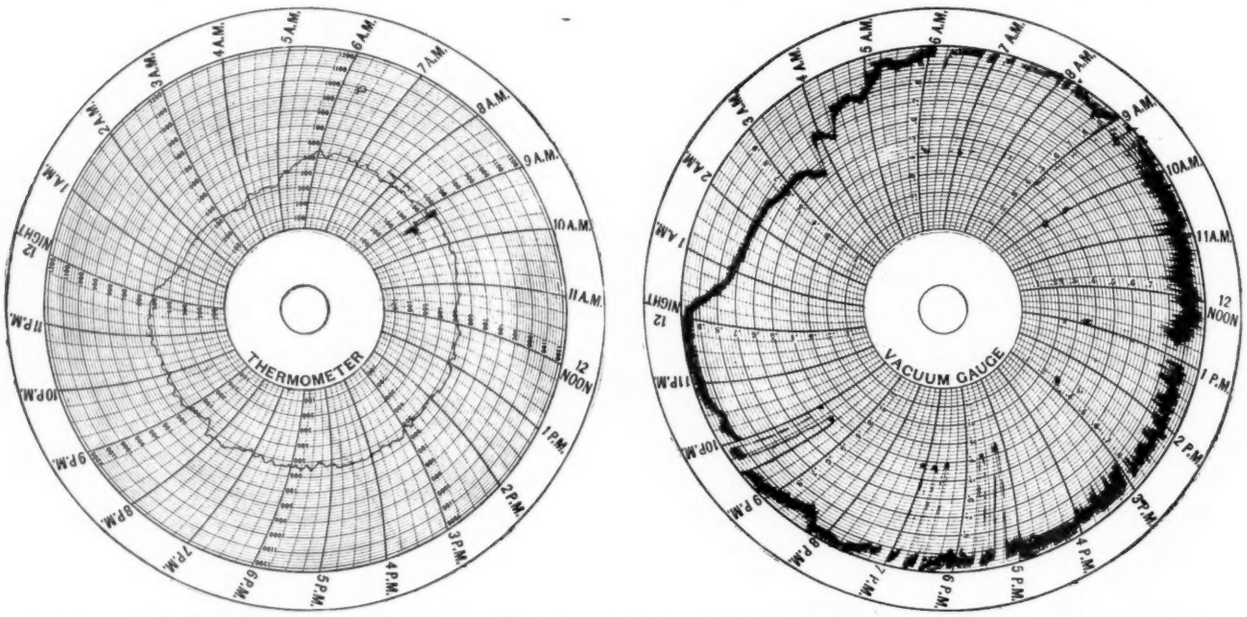


FIG. 1. TEMPERATURE AND DRAFT CHARTS WITH INDIVIDUAL DAMPERS REMOVED. AUTOMATIC DAMPER REGULATOR AT THE STACK

Just such conditions as mentioned in the foregoing can be easily handled by firemen at considerable saving in physical effort to themselves and saving in fuel to their employers by the use of the boiler damper. For example, let us consider an installation which, say, is of such a type that it will carry 200 per cent. continuous rating at, say, 68 per cent. efficiency and 125 per cent. rating at 75 per cent. efficiency, but to obtain the latter it is necessary to use the damper to decrease the draft, cut down excess air and keep the grates covered with live fire. In case of a sudden demand for steam the fire is in the best condition to meet this demand, which can be effected by gradually opening the damper and at the same time supplying more fuel to the furnace. The fire will not require hooking, poking, slicing and shaking on the part of the firemen to maintain the steam pressure; besides it will not so easily form clinker which would later need to be removed, and it will also effect a monetary saving to the plant owner by keeping the boiler in operation at an increased efficiency at a lower rating instead of a decreased efficiency by the excess air and a more laborious method of operation; also adding materially to the flexibility of operation of the installation and increasing the engine-room efficiency by maintaining the steam pressure.

The effect of excess air and damper regulation is probably most forcibly demonstrated by actual results obtained. In the first instance given in Table I the plant consisted of three 150-hp. return-tubular boilers, stoker-equipped. The usual practice was to operate two boilers until the tests were conducted showing the inadvisability of this method of operation.

To produce practically equal amounts of steam, two boilers required 1730 lb. of coal more in 8 hours and 298 lb. more refuse had to be removed than with one boiler. Had individual dampers been used and just sufficient draft supplied to burn the fuel, the efficiency with two boilers in operation would have been probably 72 per cent. and the coal required in 8 hours should have been 6100 lb., a saving of 2400 lb. of coal in 8 hours over the excess-air method of operation with two boilers.

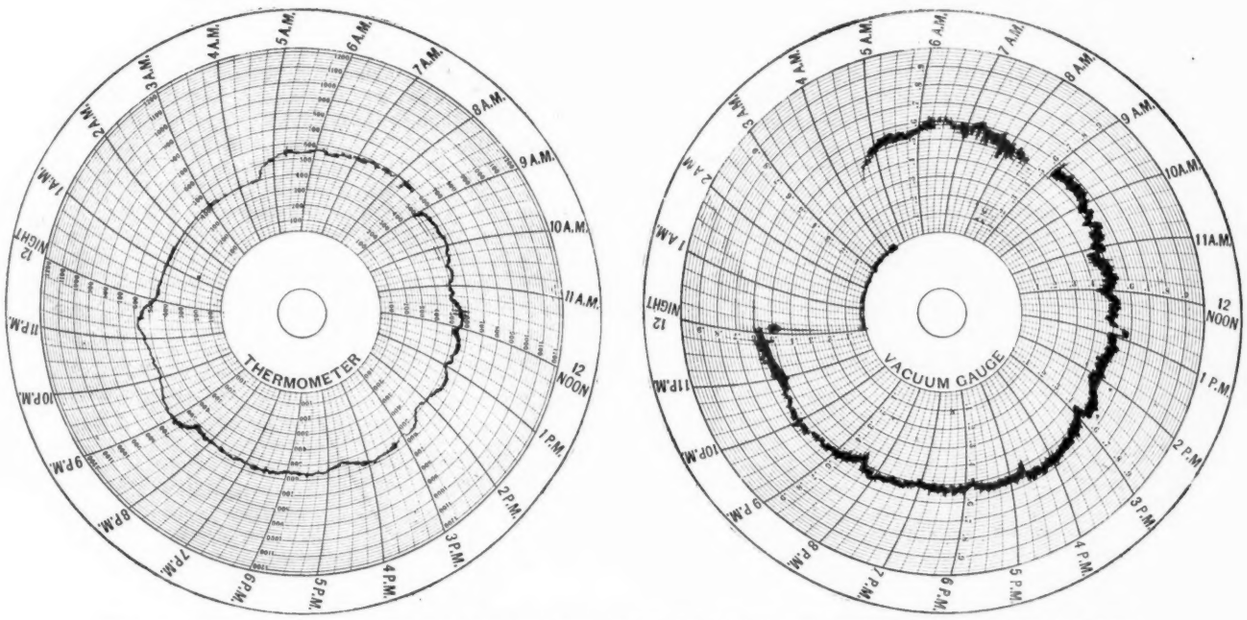


FIG. 2. TEMPERATURE AND DRAFT CHARTS, BOILERS EQUIPPED WITH INDIVIDUAL DAMPERS

TABLE I. EFFECT OF EXCESS AIR AND DAMPER REGULATION

Type of boiler	Horizontal	Return-Tubular
Number of boilers in operation	1	2
Horsepower of boilers in operation, rated	150	300
Type of stoker, Roney Type D		
Grate area of stoker, sq.ft	32.0	
Date of trial	4-23-18	4-24-18
Duration of trial, hours	8	8
Weight of coal fired, lb	6,770	8,500
Total ash and refuse dry, lb	840	1,138
Per cent. ash and refuse to dry coal	12.57	13.57
Temperature of gases leaving boiler, deg. F	690	630
Temperature of fireroom, deg. F	72	69
Draft in furnace, in. of water	0.18	0.17
Draft in smoke box, in. of water	0.38	0.40
Boiler horsepower developed	220	223
Per cent. builders rated hp. developed	146	74
Analysis of Coal:		
Moisture, per cent	1.30	1.32
Ash, per cent	10.42	11.08
Sulphur, per cent	1.44	1.49
B.t.u. as fired	13,359	13,411
B.t.u. dry	13,535	13,592
Analysis of Ash Pit Refuse:		
Combustible, per cent	17.77	20.80
Noncombustible, per cent	82.23	79.20
Gas Analysis:		
Carbon dioxide (CO_2), per cent	12.1	5.4
Oxygen (O_2)	7.0	14.3
Carbon monoxide (CO), per cent	0.0	0.0
Nitrogen (N_2), per cent	80.9	80.3
Stack and Ashpit Losses:		
Per cent. excess air	50	212
Heat lost in products of combustion, per cent	17.7	35.0
Heat lost due to combustible in refuse, per cent	2.41	3.03

The load at this plant, however, is hardly sufficient for two boilers as equipped, and some difficulty would be experienced attempting to operate this installation much below rating.

The installation and use of the underfeed stoker does not minimize in any way the importance of proper damper regulation. This factor is equally important in securing maximum combustion efficiency with this type of stoker as with stokers and furnaces that depend on natural draft to produce the air supply. Air is supplied to the underfeed stoker by a fan, and it is not dependent on the boiler damper or stack, but the boiler damper acts as a vital factor in controlling the actual conditions taking place in the combustion of the fuel, the speed at which the gases are passed through the boiler and therefore the heat-transfer rate from the gases through the tubes into the water, and in conse-

quence the efficiency of the boiler, furnace and grate as a unit. In order to obtain maximum economy consistent with the proper furnace-maintenance cost, the best practice in plant operation with underfeed stokers is to maintain a furnace draft slightly less than

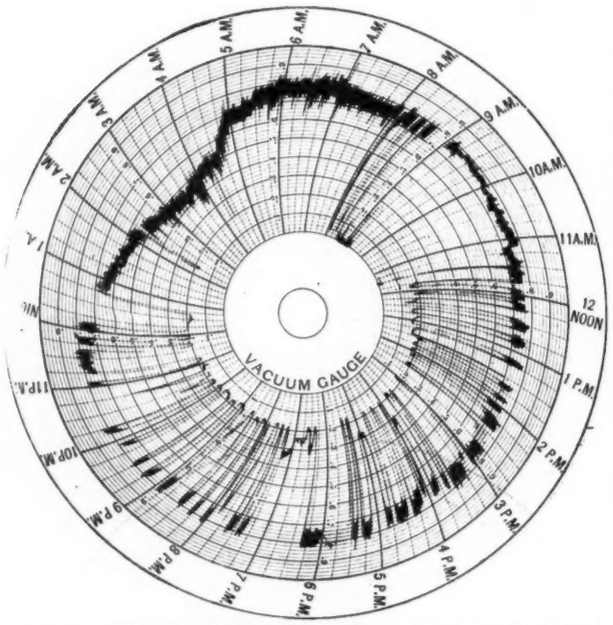


FIG. 3. CHART OBTAINED WHEN USING AUTOMATIC REGULATOR

balanced, usually about 0.05 in. of water. Maintaining this draft with proper fuel-bed conditions and a proper boiler setting brings into being the factors that establish high operating efficiencies for underfeed stokers. The influence of the boiler damper on the factors noted is best illustrated by results of test in which this effect was demonstrated and shown in detail in Table II.

These results indicate a saving of 2.4 per cent. of the heat supplied. In view of the fact that the less economical of these two performances is usually considered good practice, the saving effected is therefore the more noteworthy.

The damper should always be regulated to suit the fire and steam pressure. Firemen should not wait until the steam pressure drops, then open the damper quickly and fire hard; but as the steam pressure begins to fall, start opening the damper and increase the fuel feed. The damper should not be opened wide quickly when part of the grate is uncovered; the fire should be put in condition first. Unless some unusual condition arises, the dampers should never be closed quickly on a hot fire, but as the steam pressure rises the dampers should be closed gradually and the amount of fuel fed to the furnace decreased.

TABLE II. INFLUENCE OF THE BOILER DAMPER

Type of boiler	Ladd water-tube	
Horsepower of boiler	500	500
Type of stoker	Westinghouse	underfeed
Furnace draft during test, in. water	0.17	0.03
Draft at boiler damper during test, in. water	0.30	0.11
Temperature of gases leaving boiler, deg. F	620	565
Temperature of air entering pit, deg. F	70	70
B.t.u. per pound dry coal	13,625	13,625
Analysis of Flue Gases:		
Carbon dioxide (CO_2), per cent	14.2	15.7
Oxygen (O_2), per cent	4.3	2.3
Carbon monoxide (CO), per cent	0.0	0.0
Nitrogen (N_2), per cent	81.5	82.0
Per cent. air excess	25.2	12.0
Heat lost in products of combustion, per cent	13.1	10.7

TABLE III. EFFECT OF DAMPER REGULATION ON ECONOMY

Type of boiler	Horizontal return-tubular	
Horsepower of boiler	90	90
Kind of fuel	Natural gas	
Heating value, 1,000 B.t.u. cu.ft. standard conditions		
Position of boiler damper	Open	Partly closed
Draft at damper, in. water	0.32	0.18
Temperature of gases leaving boiler, deg. F	400	450
Temperature of air entering burners, deg. F	72	72
Analysis of Flue Gases:		
Carbon dioxide (CO_2), per cent	3.2	8.8
Oxygen (O_2), per cent	14.4	5.6
Carbon monoxide (CO), per cent	0	0
Nitrogen (N_2), per cent	82.4	85.6
Per cent. excess air	200	33
Heat lost in products of combustion, per cent	19.4	10.3

The effect of damper regulation on the economy of boilers fired with natural gas is clearly shown by results of test data in Table III.

Automatic control of the boiler damper, which control can be also connected to the burners, so that the boiler damper is closed tight and the gas shut off

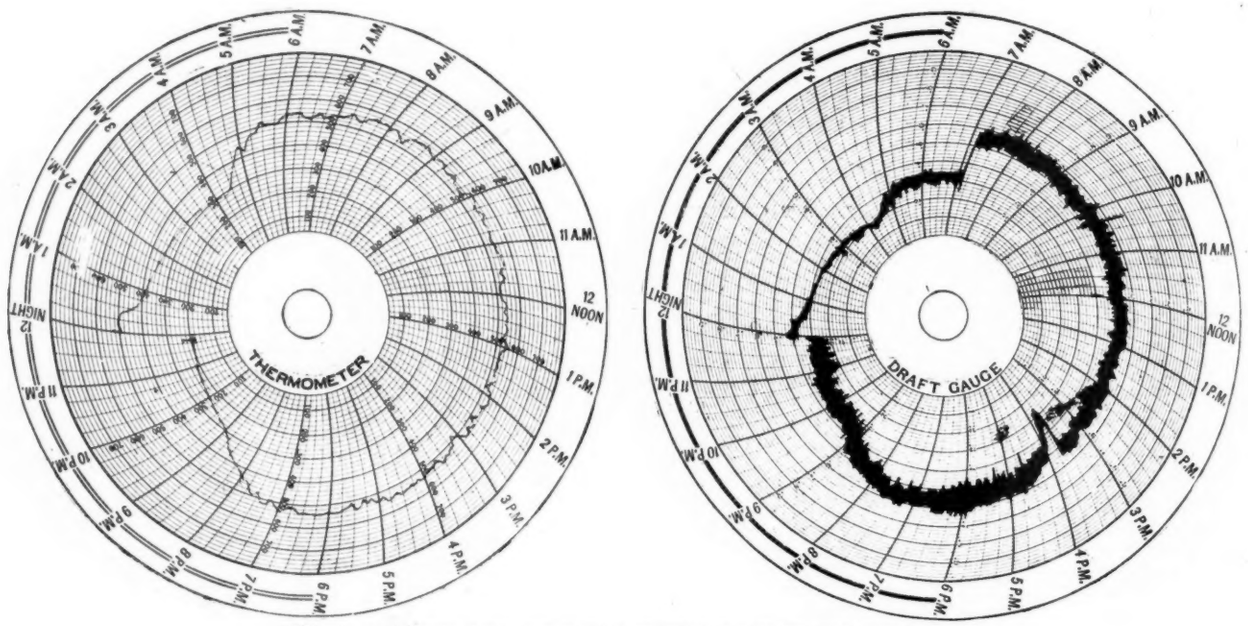


FIG. 4. CHARTS OBTAINED WHEN THE DAMPER WAS NOT USED

from the burners when the steam pressure is above normal with gas on the burners and the damper partly open when the boilers require firing to maintain the steam pressure, lends itself to economic operation and low attendance cost for this type of unit, especially in the smaller plants. This method of operation possesses the advantage that the burners can be set for the proper mixture by analysis of the gases of combustion and that this setting need not be tampered with by adjusting the air or gas supply. Large variations in load can be met by cutting burners in and out of service.

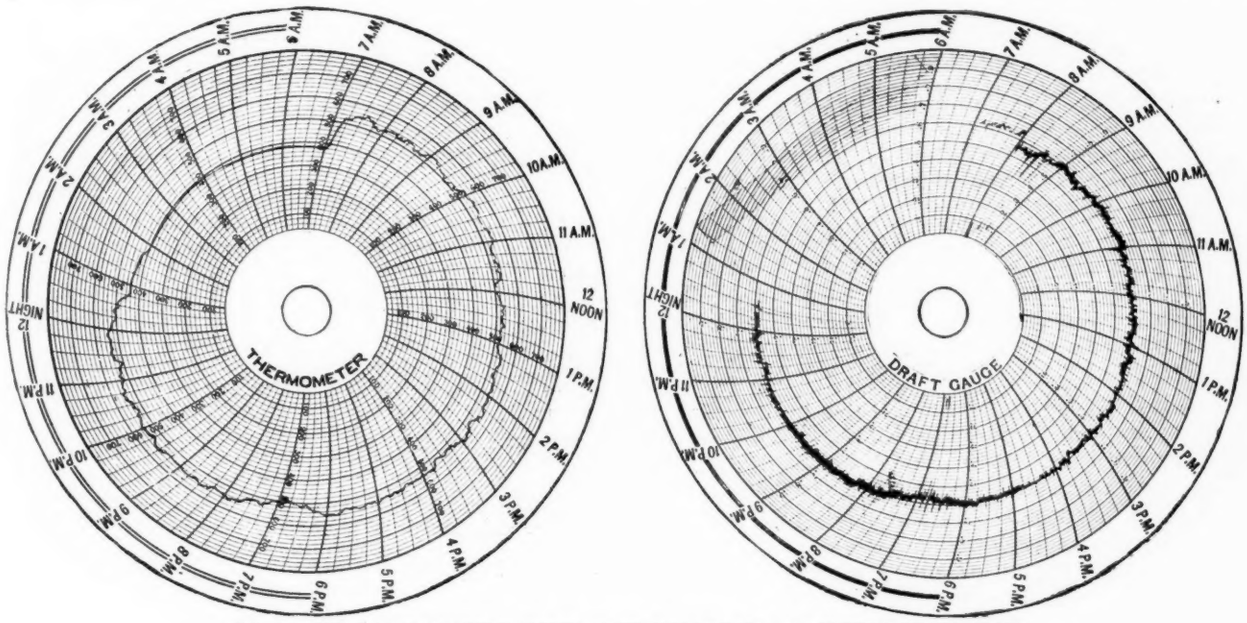


FIG. 5. CHARTS OBTAINED WHEN THE INDIVIDUAL DAMPERS WERE USED

A series of charts taken of conditions prevailing during 24 hours on a boiler in actual plant operation are shown herewith and will illustrate the effect of using the damper to maintain the heat in the setting and save fuel during banking periods.

The charts shown in Fig. 1 indicate respectively the draft and temperature of gases at the boiler damper of one of a battery of two 375-hp. Babcock & Wilcox boilers, standard baffle, equipped with Roney stokers and having one stack 150 ft. high mounted directly on the boilers of each battery. The individual dampers had been removed from the boilers as they interfered with an automatic damper that had been placed in the stack, hence no damper was used to bank the boilers. As a result the temperature of the gases leaving the boiler was actually below the steam temperature for four hours, and it required about one hour to establish usual operating conditions and get the boiler setting fairly well heated.

The charts shown in Fig. 2 were taken from a similar location on a similar unit, but the boiler was baffled and set in a different manner, having a large combustion chamber with considerable refractory surface therein; the boilers were equipped with individual dampers. The effect of using the damper in banking can easily be noted. At no time during the banked period was the temperature of the escaping gases less than 50 deg. F. above the steam temperature, and when the boiler was put back in service the time required to

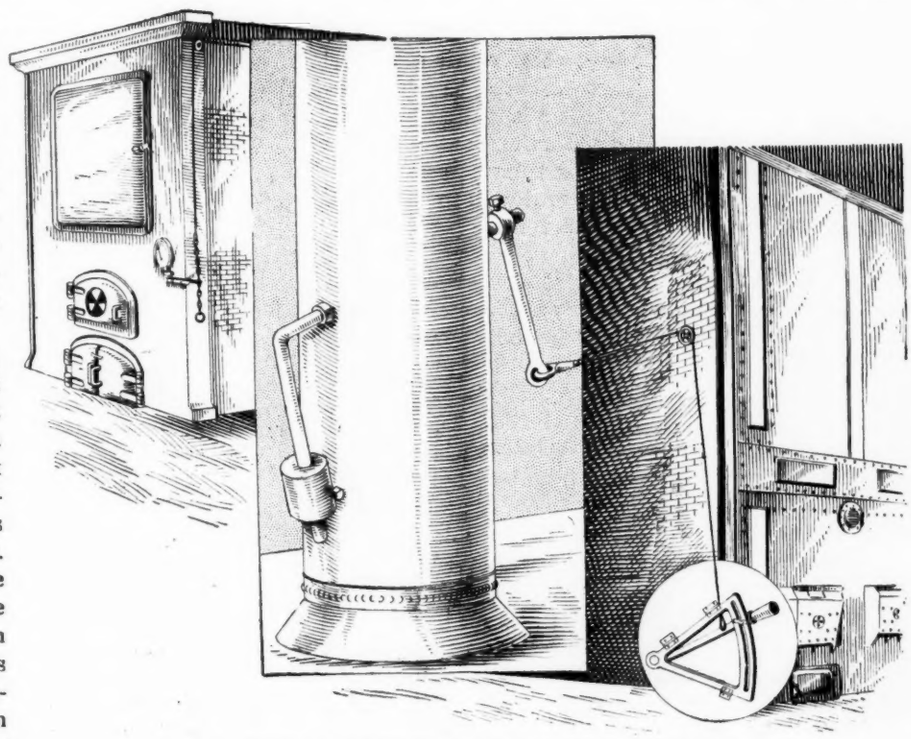


FIG. 6. TWO TYPES OF INEXPENSIVE DAMPER CONTROL

place it in active operation was about ten minutes notwithstanding the increased amount of refractory surface in the furnace.

This plant operated from fourteen to sixteen 375-hp. boilers during the heavy-load periods and banked from 8 to 10 boilers during the light-load periods. After the boilers were again equipped with individual dampers, easily controlled and with dampers used in banking, it was estimated that a fuel saving of from 14 to 16 tons of coal daily was effected thereby.

In Fig. 3 is shown a chart that was taken from a boiler of similar size as the foregoing, showing the draft variation at the damper when equipped with an automatic regulator.

The charts in Fig. 4 indicate, respectively, the draft and temperature of escaping gases at the damper of one of a battery of two 400-hp. Babcock & Wilcox boilers equipped with Murphy stokers and dutch-oven furnaces, the battery being equipped with one stack 150 ft. high, mounted directly on the boilers. The break in the chart at midnight is due to the fact that the chart was changed at that time. That the damper was not used is evident from an examination of charts.

In Fig. 5 are shown charts taken from an identical installation at a different station, where individual damper control was installed and used. This is an excellent set of charts and clearly indicates the results that can be accomplished by intelligent regulation and use of the damper.

In order that firemen may be encouraged to use the damper, a form of control should be adopted that is easy to operate and readily and quickly accessible. Damper controls should always be installed so that in case the control wire or rope breaks, the damper will be thrown open by weights attached, thereby avoiding any possibility of the fire flaring back into the boiler room and injuring the employees.

Two types of control, inexpensive and easily installed and one of which is especially adapted to installations consisting of the smaller-sized units, are shown in Fig. 6. This control need not be confined to the boiler as to location, but can be extended to any part of the fireroom where it is convenient for the firemen to operate it by means of a system of pulleys. The other sketch illustrates a type of control that lends itself to convenient installation and operation on units of the larger sizes, usually from 250 hp. boilers and upward.

Points in Pump Selection

By B. N. Everett

PUMPS as a rule have very high load factors; that is, ratio of power consumed to maximum demand is high. Also, the power consumption per dollar invested in the apparatus is higher than in most other power-consuming equipment. It would appear, therefore, that the matter of power consumption should be given consideration, especially when the variation of power requirements of different pumping arrangements is so great.

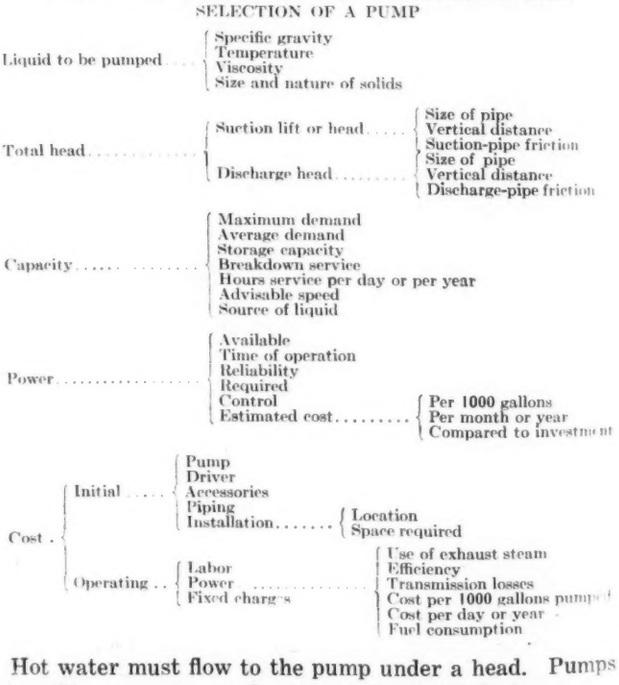
The fact that exhaust steam from direct-acting pumps may often be used to heat feed water has led to the habit of assuming that steam economy is of little importance. But which is the better economy—to use efficient pumps and let water enter the boilers considerably below the boiling point at times, or to allow heat to escape to the atmosphere because of an excess of exhaust steam from inefficient pumps? In the first case the deficiency in feed temperature must be made up by fuel and in the second case fuel is burned to generate the steam that passes through the pumps and heats the feed water and also the steam going to waste.

The word "efficiency" as ordinarily applied to pumps is of little value. For instance, a steam pump with an efficiency of 80 per cent. (that is, the indicated horsepower of the water end is 80 per cent. of the indicated horsepower of the steam end) was replaced with an electrically driven triplex pump with an over-all efficiency of 70 per cent. (that is, the water horsepower was 70 per cent. of the horsepower supplied to the motor). The electric pump was driven through the medium of an efficient engine and generator and required only 6 lb. of fuel per 1000 gal. pumped, whereas the steam pump required 42 lb. of fuel per 1000 gal. pumped, which is a difference of several hundred per cent. In this particular case besides the reduction in fuel consumption one man's labor was saved, as the steam was supplied from a separately fired boiler.

The accompanying chart gives the principal points to be considered by an engineer in selecting a pump. No one but an engineer with a knowledge of various classes of pumping machinery and all the individual requirements of the plant should handle the matter. The various items are so interdependent that all must be borne in mind while each is considered individually.

The character of the liquid to be pumped has a direct bearing on the size of pipe to use, the advisable speed, the suction lift of the pump, and the power required.

CHART SHOWING POINTS TO BE CONSIDERED IN THE SELECTION OF A PUMP



Hot water must flow to the pump under a head. Pumps handling sewage, sand, etc., need special features.

In deciding on the size of pipe to use, each of the following should be considered: Liquid to be pumped, total friction head of pipe and fittings, maximum capacity, average demand, hours service per day, per year, etc., and cost of power. It is a problem of balancing the

cost of power consumed to overcome friction against the cost of the line installed. It is somewhat analogous to figuring the size of an electric transmission line. It requires power to overcome friction in proportion to the amount of liquid pumped and the extra first cost of a larger size of pipe will often be returned in saving in power in a short time.

Some time ago data sheets giving the friction of water flowing through pipes and elbows were revised by pump manufacturers because they did not agree with practice. Pipes soon get scaled up inside and offer more resistance than when new.

When a pump is pumping to a system direct, without any storage provided, it must be large enough to meet the maximum demand. Care should be taken that no loss of time is incurred through lack of pump capacity. A woolen mill had a number of machines that required filling with liquid periodically. They were served by a pump that required ten minutes at each filling. It was shown that the output could be increased by reducing this period to two minutes. A pump of the required capacity would have five times the displacement of the old pump, which was of ample capacity to supply the average demand of all machines. So, by installing a storage tank of a capacity to meet the maximum demand the filling period was reduced to less than two minutes. Besides, power was saved by reducing the many starting and stopping periods.

Two Pumps Sometimes More Economical Than One

Sometimes two pumps can show better economy than one. A manufacturing plant was using water for all services by pumping from artesian wells to a tower tank under a total head of 120 ft., and the water requirements had outgrown the capacity of the pump. Approximately half of the water was used for cooling gas engines and air compressors in the power plant, for which service a head of 30 ft. was ample. A separate pump and control tank were installed and the power required to pump water was reduced 30 per cent., at the same time increasing the pumping capacity for future requirements.

The calculations of the actual power consumption of a pump should include all the power used or necessarily wasted. The heat lost by radiation and valve leakage in keeping a pipe line and steam pump warm and ready for service often amounts to considerable per 1000 gal. pumped. A belted triplex pump, even with an efficiency of 80 per cent., if controlled by a bypass valve, may be consuming power at its maximum rate and actually delivering only a small percentage of its capacity.

As a general rule direct-acting steam pumps should be employed only where use of all the exhaust steam is possible, or where service is intermittent and better economy will not warrant a larger investment. Steam-valve leakage often amounts to an enormous total, and pump slippage is often a more formidable loss than is suspected. Consider a direct-acting steam pump supplying an average demand equal to 30 per cent. of the normal capacity of the pump, pump slippage at normal rate amounts to 15 per cent., and the pump is controlled by a throttling type pressure control valve. Then the slippage (15 per cent. of capacity) amounts to 50 per cent. of the discharge (30 per cent. of capacity) and the steam consumption due to slippage is 50 per cent. instead of merely 15 per cent. Under these conditions also the radiation losses and valve leakage amount to more per 1000 gal. pumped. So it is often the case that the power consumption per 1000 gal. pumped is more than double what would be indicated at a normal speed.

Tilting pumping traps are used extensively in handling condensation and feeding boilers, and very low steam consumptions are obtained when pumping hot water. Tests showing steam consumption when pumping cold water would be interesting.

In a certain plant that used a great number of steam pumps, serving evaporators, washers, coolers, etc., the pumps were allowed to run without oil and at destructive speeds and abused generally. Production was interrupted almost daily in one department or another by pump trouble and the pump repairman's hair was gray. The chief engineer said that although he could use the exhaust from the pumps, he was installing single-stage centrifugal pumps direct-connected to electric motors in every case where they could be applied, simply because they are more fool-proof and increase the factor of safety against interruption of service.

In the case of centrifugals even greater care should be taken in making the application, especially in regard to the correlation of total head and peripheral speed of impeller to the motor speed, and the means of regulating capacity.

Knowing the "Why" of a Rule

Knowing rules or formulas is in itself an essential thing and should be encouraged, but knowing a rule without knowing its derivation or modifications may create an embarrassing situation to say the least. For example:

In locating the center line for a new engine that had to be at right angles to a fixed line, the old rule, 6, 8 and 10, did not fit well on account of certain fixed obstructions in the way of the 10-ft. diagonal line. The erecting man was "up against it right." He only knew the rule in the measurements given and could not translate it into others. If the fellow who taught him the use of the rule had taken a little more time and told him that 6, 8 and 10 meant simply a proportion—easy to remember—and not the only set of measurements that could be used, he would have done him a still greater favor. He need not have gone into a lengthy dissertation on the *pons asinorum* or even demonstrated that in a right-angle triangle the square of the base plus the square of the perpendicular is always equal to the square of the hypotenuse; simply that any proportionate measurements, inches, feet, meters or what not, would produce the same results.

A little natural curiosity to know the "whys and wherefores" of things will help in the right direction.

Not 100,000 Tons of Coal

Frank W. Casler, superintendent of power plants, Public Service Electric Co., Newark, N. J., advises that the last part of the second paragraph, page 399 of the Sept. 10 *Power*, should read "30,000 tons," instead of "100,000 tons." Mr. Casler says that the 100,000 refers to the amount saved in dollars.

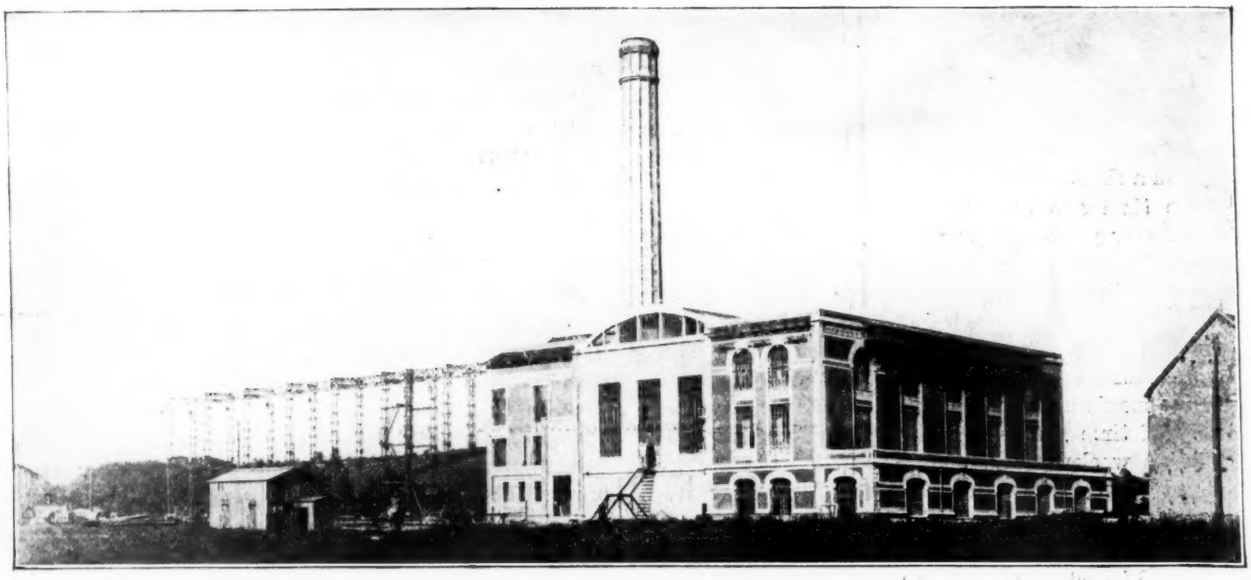


FIG. 1. 15,000-KW. STEAM GENERATING STATION CONSTRUCTED EXCLUSIVELY FOR AMERICAN EXPEDITIONARY FORCES

Electrical Developments for American Army

By ROBERT K. TOMLIN, JR.
Staff Correspondent in France

Present plans for the troops in France provide for 50,000 kw. Technical board, newly created, controls supplies and coördinates the work of design and construction. Electrical machinery difficult to get.

WHAT are the electric-power requirements of the American Expeditionary Forces and what is being done to meet them?" This is, in substance, the question I put to a captain of engineers at the headquarters of our Services of Supply in France who, since giving up his position in civil life with the Commonwealth Edison Company of Chicago, has been in responsible charge of electrical matters for our armies overseas. As a result of this interview it is possible to discuss in a general way the situation with which our electrical engineers in the American Expeditionary Forces are dealing. It should be understood, however, that there is nothing of finality in what follows. Conditions change rapidly. One day an electrical engineer officer may be completing plans for the development of a certain amount of power at a certain place; the next week he may be faced with the problem of doubling the output originally contemplated. It generally works this way; that is, increase rather than decrease in the amount of work to be done. Then, too, sites where no provision of power was ever anticipated may suddenly become important centers of activity at which electric installations must be made or to which transmission lines must be built. It is nothing new for a 10,000-bed hospital project to spring up almost overnight.

Coupled with these conditions of uncertainty and change—conditions inherent in the engineering work of war as distinguished from that of peace—are others which make the job of the electrical engineer anything but a sinecure. The chief of these is the scarcity of electrical material and equipment available for quick delivery. It is well to recollect that we are working in a country that has seen four years of war. Industry has been mobilized. Electrical equipment of all sorts which was of use to the Allied armies early in the campaign has long since been rounded up and placed in service, leaving little new stock on hand for the man who arrives upon the scene three years or more after hostilities began.

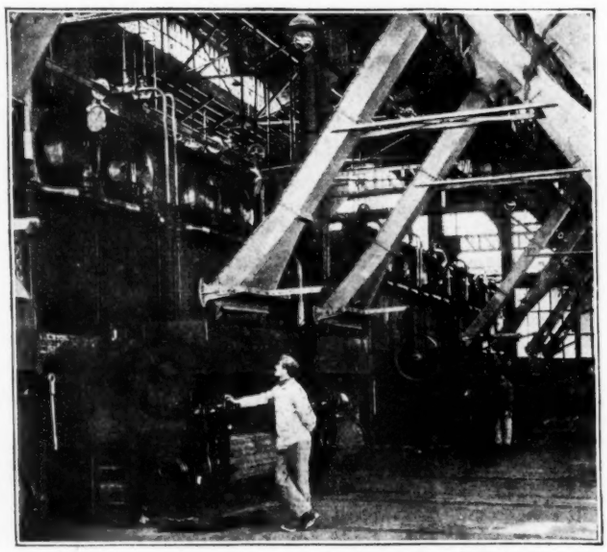
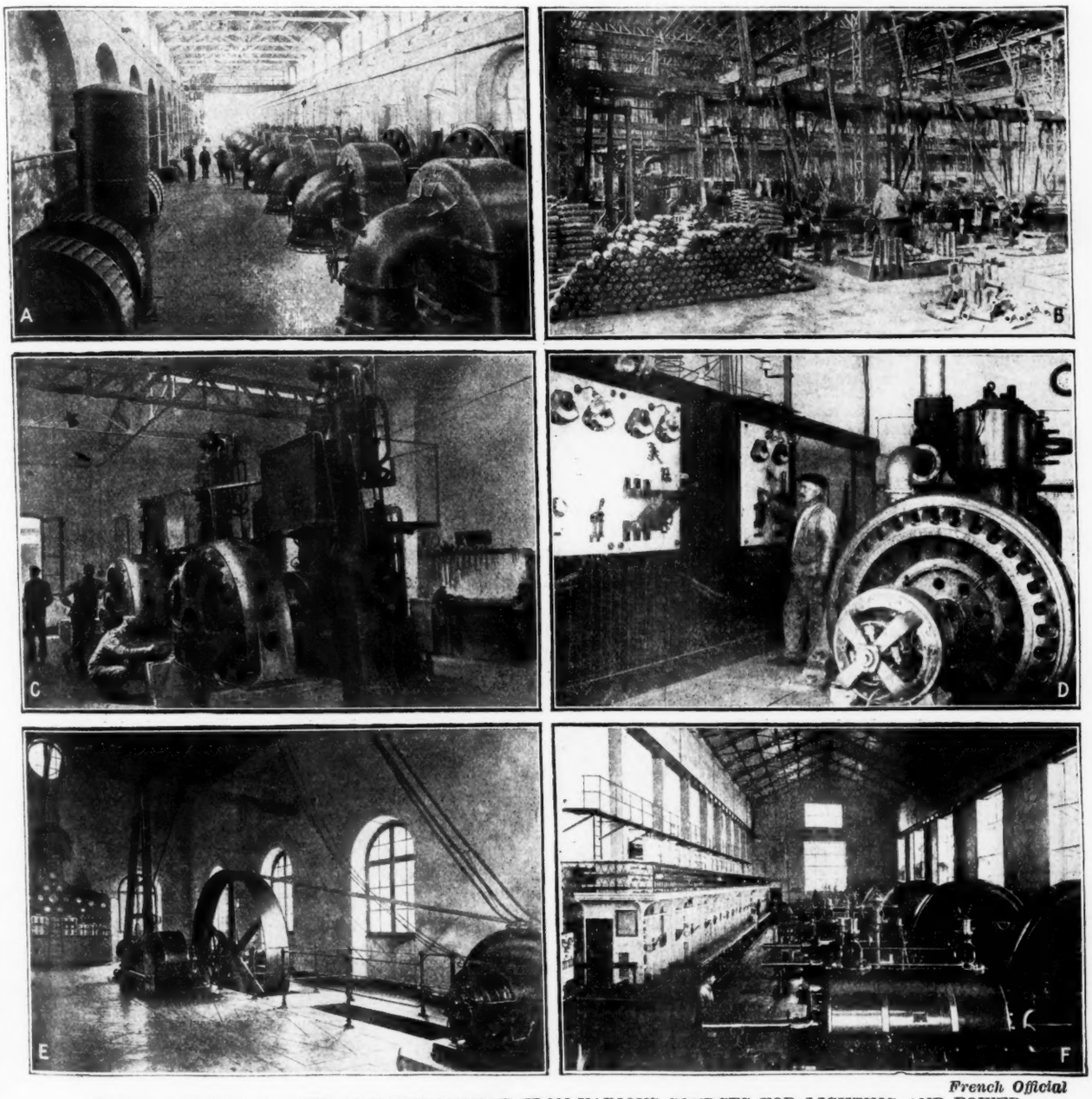


FIG. 2. BOILER ROOM OF A BIG FRENCH POWER PLANT

"My best guess as to the electric power demands of the American forces at the present time in France," said one of my informants, "is

from 50,000 kw. to 60,000 kw. What the future will bring forth no one can tell. Certainly we shall have to be prepared to meet additional requirements. Strung along between the seacoast and the front are scores of places that are calling upon us to provide electricity for lighting and for the operation of machinery. In the first category come the hospitals, many of them equivalent to fair-sized towns. Some are already built; many are now under construction; still more are contemplated. They present no complicated problem for the electrical engineer. The hospitals generally mean merely interior wiring, for frequently the sites are within reach of existing central stations."

More difficult situations from the point of view of the engineer who is called upon to furnish electric power are presented at such installations as repair shops for mechanical equipment and ordnance, docks and refrigerating plants. There are also aviation production centers containing large numbers of machine tools requiring power for their operation. In France today there are thousands of American army motor trucks, and their repair centers demand the installation of power plants. Then, too, there are the several storage and supply depots where the lighting problem is no small matter. Our water supply service is engaged upon many projects which call for the furnishing of electric power for pumping. It is apparent, therefore, that the demands made for electricity are extremely varied. Another factor which adds difficulty to the work is that power requirements must be met at many widely scattered points. It is not a question of equipping and putting into operation one or two big central stations, but rather of providing numerous segregated plants.



French Official

FIG. 3. FRENCH "USINES" USE ELECTRICITY FROM VARIOUS SOURCES FOR LIGHTING AND POWER

As a general policy governing the operations of the Technical Board and the electrical division of the Services of Supply, it has been considered best, wherever possible, to make additions to existing French central stations rather than to build new ones of our own, although a certain amount of new work has been undertaken. The fuel situation demands careful economy of coal, and transportation conditions likewise make it necessary to conserve freight cars. The policy is, whenever possible, to put in additional boilers, generators and transmission lines at a French power station rather than to embark upon new projects.

Another reason for making use of existing central stations, either in their present condition or enlarged, is the difficulty of securing skilled operators. Even when enlarged, these plants can be run by adding a few members to the force already on the job, which is, of course, a much simpler proposition than building a new plant and training a new operating crew. At present there is a great shortage of skilled labor available for central plant operation. Several large plants are now operated exclusively by women who work on heavy repairs and even fire boilers.

Referring to the matter of power-plant enlargement, the captain of the Engineer Corps explained to me that the French central stations at present have little money for extensions. No equivalent of the American "new-business" department exists in France. Such enlargements as are being made for use by the American Expeditionary Forces are being paid for by the United States. This same thing applies to transmission-line construction. Our policy is to adopt overhead construction entirely in connection with the distribution of electrical energy, of which we have already built, or have planned to build, about 132 miles. We are paying for all the lines we build, and the understanding with the French government is that they are the property of the United States. When the war is over it will be possible for us to recover the material we have put into this work or, through some board of appraisal, negotiate with the French for its purchase if desired.

The situation affecting the installation of electric power plants and transmission lines for the American armies is different from that of the French. This difference is accounted for, in some measure, by the temperament and customs of the two peoples. One enters a French "caserne," or barracks, and there is not an electric light to be seen. The men get along with lamps and candles. In marked contrast are the American barracks, most of which in the zones back from the immediate fighting fronts are wired and equipped with electric lamps.

Planning for Peace Times as Well

While our engineers are working at present to supply the immediate needs of the American Expeditionary Forces, it is absolutely essential now to look ahead to the time when a declaration of peace will release for commercial use the vast number of sources of electric power which have been or are being developed today strictly for the business of waging war.

In central France there are being built for American army use more than a score of so-called "usines"—manufacturing plants of one sort or another—required for the production or repair of war material. All of these installations call for electric power installations. The situation, therefore, is one which involves planning in order that present enterprises may be adapted to after-the-war conditions. Certain it is that our participation in the war will eventually change the industrial map of France. The future will see areas which in by-gone days have been devoted to the easy-going farm life of the French provincial population develop into great industrial centers. This must be the outcome, for we are now seeding France with electric power installations, and the day is surely coming when there will be a big industrial harvest to reap. We are putting in now electric power plants and transmission systems which can readily be adapted to peace-time use.

Water-Power Development

In addition to several steam-electric power stations that have been built by American labor in France, we have under consideration half a dozen projects for the utilization of water power by means of the "outdoor type" of electric generating station. The design provides for the utmost simplicity in construction—merely a waterwheel and generator on substantial foundations housed under a rough shed of some sort. However, the idea is ultimately to make these hydro-electric plants permanent. They will be left in their rough state for the duration of the war and will then be inclosed in a permanent masonry structure designed by French architects to meet the requirements as to exterior appearance which are a matter of more concern over here than in the United States. Hydro-electric plants of this type now under consideration are rated at from 2000 to 8000 kw. and will operate under moderate heads.

In contrast to these installations is another hydro-electric development of 9000 kw. which has been partially completed by the French. It is probable that the American forces will take over this work, finish it and operate the completed plant. In so far as possible the American-built and French-built systems of electric power transmission will be interconnected.

French Practice Adopted

In view of present shipping conditions, where tonnage is being reserved for fighting men and their food rather than for other supplies, the Technical Board is endeavoring to procure practically all electrical equipment in France. There are, it was explained to me, two good reasons for this policy. In the first place, shipments of American-made products needed for power development are difficult, if not impossible, to secure. In the second place, the French equipment, built to conform to current French practice, is in many cases practically obligatory, especially in view of the fact that it must be used not only for present military needs but also for commercial service after the war.

On many details of electrical power development and transmission French and American practices are at variance, and certain American equipment would be practically useless over here. The French employ almost no direct current, the almost universal preference being for 50-cycle, three-phase currents. American equipment of either 60 or 25 cycles cannot be employed in France.

Earthing Power-Station Equipment

By P. H. ADAMS
Assistant Engineer, Public Service Electric Company, Newark, N. J.

In the article, "Power-Station Earth Connections," appearing in "Power" under date of July 9, various methods for properly installing and maintaining earth connections were discussed. The necessity for draining stray currents from the building frame to earth was also explained. It is the purpose of this article to discuss the earth connections of station equipment and reasons for making them.

BEFORE going into detail there are three general rules applying to all earth wires, which should be kept in mind:

First: Earth connections must *not* be incased in iron pipe or pipe of any other magnetic material. The inductive effect of such material surrounding the earth conductor will retard the flow of ground current, and in many instances may cause this current to jump from the conductor to the incasing pipe or to adjoining apparatus and do considerable damage.

Second: Earth connections should be of such size that in case of trouble the circuit-breaker on the supply circuit will open before the earth connection burns off.

Third: The connection to the earth pipe or plate must be of a positive nature, so protected that it cannot easily be broken or subjected to mechanical injury.

The electrical equipment of the modern power station is made up of many types of apparatus. Part of the equipment is for the generation, transformation or transmission of the electric power and part of it for protecting this equipment from lightning and other disturbances.

For convenience, the equipment of the station may be divided into two general groups—arresters, and general equipment.

The lightning arrester of today is used to protect the system not only from lightning, but also against surges and oscillations set up by arcing grounds, switching changes, sudden load changes, etc. Large systems having both overhead open-wire and underground cable distribution, are subject to both direct and reflected voltage disturbances which the modern lightning arrester is designed to discharge.

The thorough protection of any system entails the investment of a comparatively large amount of capital in lightning arresters. The most essential part of the arrester installation is the earth connection, for without this feature the arrester is worse than useless. Every lightning arrester should have as direct a path to earth as possible. Avoid sharp bends in this connection wherever possible. This earth connection should be insulated from the building structure and entirely independent from all other earth connections.

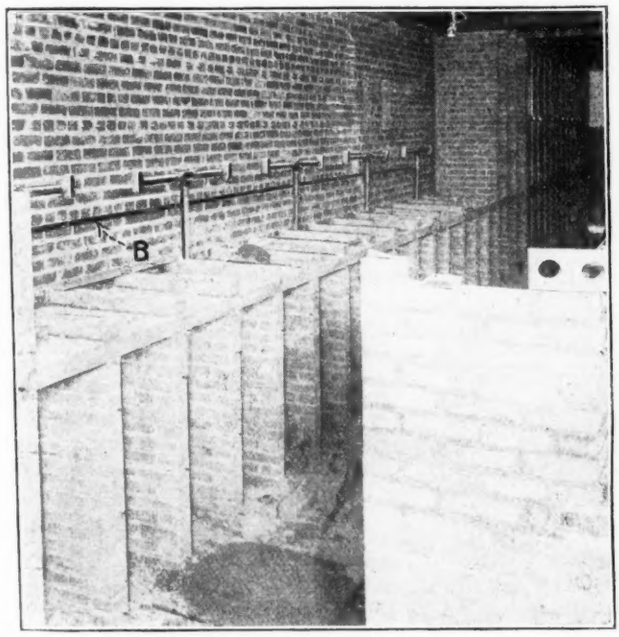


FIG. 1. METHOD OF PLACING EARTH BUS IN SWITCH CELLS DURING CONSTRUCTION

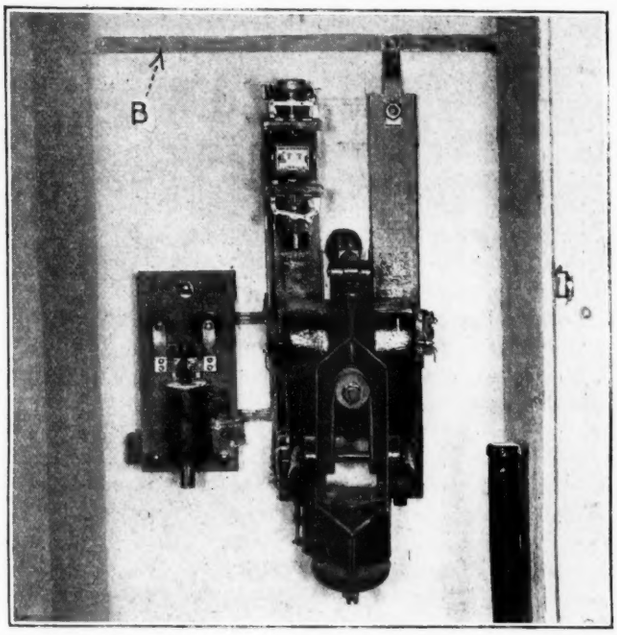


FIG. 2. METHOD OF CONNECTING OIL-SWITCH MECHANISM TO EARTH BUS

It is common practice to consider that once the arrester earth connection is made, no further attention need be given it, but this is not true. In order to secure the insurance the lightning-arrester investment should give, it is not only necessary to install them as already described, but they must be properly maintained. The test for earth-connection resistance is a simple one, as outlined in a previous article, and should be made periodically. There is no excuse for leaving this important item to chance.

Lightning arresters are divided into as many classes as there are voltages in the station. Each class of lightning arrester must be connected to earth inde-

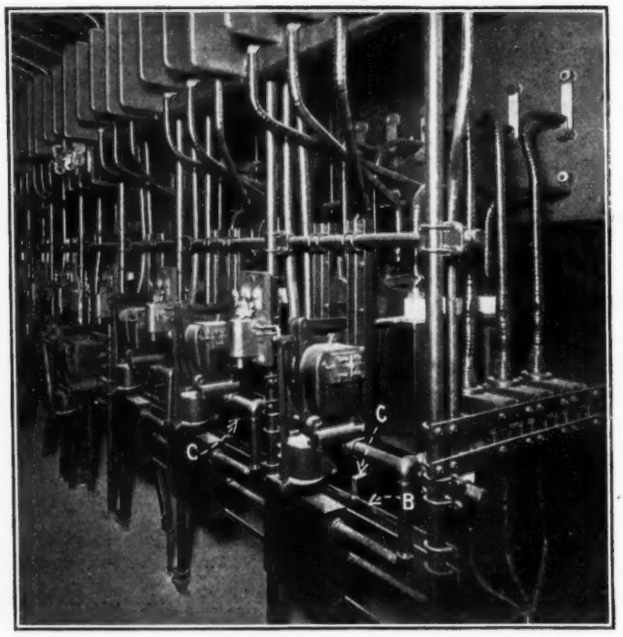


FIG. 3. EARTH-BUS CONNECTIONS WHERE OIL SWITCHES ARE MOUNTED ON PIPE FRAMEWORK

pendently, in order to protect the low-tension equipment from discharges occasioned by disturbances on the high-tension system. There are instances on record where a common earthing bus, used for several classes of arresters, became accidentally disconnected from earth, and a heavy discharge from the high-tension system backed up from the earthing bus to the low-tension arresters, burned them up and did considerable damage to the other equipment.

From the foregoing the reason for a safe lightning-arrester earth connection is readily seen, but why should the other equipment be earthed in any way?

All electrical conductors are insulated from one another and from other material in general, but this insulation may fail at any moment, thereby connecting the frame of the machine to the electric circuit. If there was no earth connection to this frame, the station attendant's life would be in danger until the trouble was discovered and repaired. This discovery might be based on a serious shock received by the attendant or even his death. It is therefore essential, in order to safeguard human life as well as the equipment, to make a secure earth connection to the frame of each piece of apparatus operating at 500 volts and above.

Were it possible to procure an insulating medium of such perfect quality that it could not fail, the earth connection would still be as necessary as before. This is particularly true with regard to alternating-current machines.

Every electrical conductor, when carrying current, produces or induces on adjacent metals, from which it may be thoroughly insulated, an electric charge the potential and capacity of which is dependent directly on the voltage and frequency of the circuit and inversely on the thickness of the insulation on the conductors. This action is similar to that of a condenser of which the conductors form one plate and the frame the other. The conductor insulation corresponds to that between the plates of a condenser. The potential of the electrostatic charge induced on the frame will approach the circuit voltage as a limit, and this may be very high and dangerous. For the protection of life and property it is necessary to drain off this electrostatic charge, and this is accomplished by connecting the machine's frame to earth.

The general equipment of a station may be divided into three classes: (1) Machines (rotating and static); (2) switch gear; (3) instruments and instrument transformers. These three subdivisions should, wherever possible, have entirely separate and independent connection to the earth pipes or plates.

The term machines includes generators, converters, transformers, regulators, etc. The size of the earth connection for machine frames should begin with No. 6 A.w.g. (B. & S.) as a minimum for machines below 50 kw. For machines above 50-kw. capacity, allow about 500 cir.mils per kilowatt to a maximum of 1,000,000 cir.mils. This seems to be a safe basis for computing the size of the earth connection, since the circuit-breaker should open before a wire of such size has had time to fuse. The maximum size is set at 1,000,000 cir.mils, because extremely large machines should have special attention from the engineers in regard to this matter.

It is customary to install an earth bus in the station, to which all the machine frames are connected. This bus should be as large as the largest machine requires and be earthed in at least two places.

The switch gear of the station consists of oil circuit-breakers, rheostats, controllers and various other appurtenances used in distributing the current generated, to the various busses and outgoing feeders. The current-carrying parts of this equipment are usually supported by and inclosed in iron or steel parts, from which they are thoroughly insulated. These support-

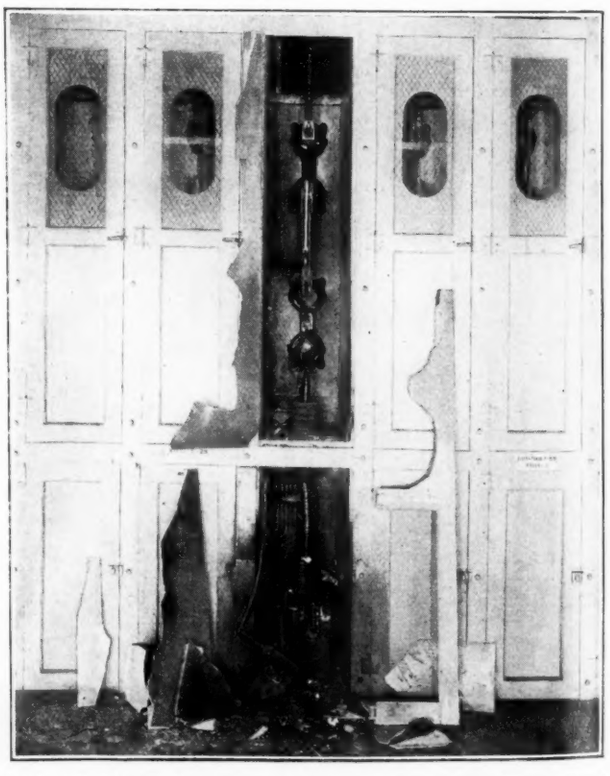


FIG. 4. CLOSE-UP VIEW OF POTENTIAL TRANSFORMER AND FUSE COMPARTMENTS

ing or inclosing parts, however, are subject to the same conditions as machine frames as far as induced voltage is concerned and, unless they are securely earthed, may cause material damage to the equipment.

The switch-gear frames are particularly liable to contact with the current-carrying elements since this equipment has to rupture short-circuits and withstand other strains imposed on the station equipment through carelessness or accident.

Figs. 1 to 3 show methods of earthing switch-gear frames. The earth bus is shown at *B* in each case. Fig. 1 indicates how the earth bus is installed in the brickwork of the switch cells during construction, Fig. 2 gives the method of connecting the oil-switch operating mechanism to the earth bus, and Fig. 3 shows the earth bus and connections where oil circuit-breakers are mounted on pipe framework. The latter is part of a 440-volt three-phase 60-cycle installation. Notice the connection *C* between the channel iron, that the oil switch and operating mechanism is mounted on, and the earth bus.

An instance occurred in the writer's experience where an oil circuit-breaker frame was left without an earth connection by the construction foreman. A short time after the equipment was placed in operation, this circuit-breaker flashed over to the frame, and the control circuit being the path of least resistance to earth, the high-tension current jumped to it and did so much damage that the entire control system of a large sub-

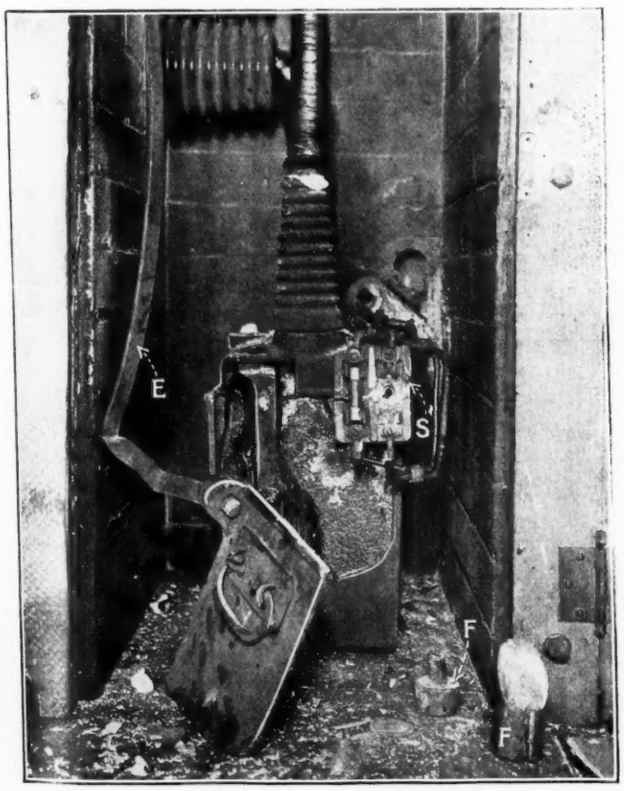


FIG. 5. CLOSE-UP VIEW OF TRANSFORMER

station had to be renewed. In addition to this expense the substation was shut down for several hours while temporary repairs were being made. There are doubtless many other similar instances which have been attributed to other causes. The omission of secure earth connections to switch-gear frames is such a common one that many cases of switch failure may be attributed to this oversight.

Instances have come under the writer's observation where a bus was installed and all the switch-gear frames were connected thereto but the earth connection

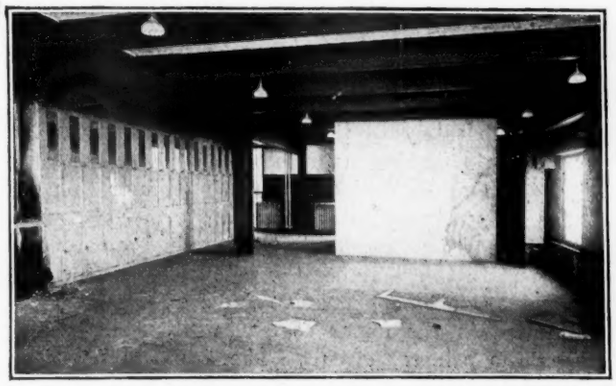


FIG. 6. GENERAL VIEW AFTER THE TROUBLE

was omitted. This was due to carelessness on the part of the workmen and largely due to the foreman's failure to realize, and impress his workmen with, the importance of this vital feature of the station wiring. The foreman should also be careful to impress his men with the importance of earth connections. The well-trained electrician should feel that his work is unfinished until the earth connection is made.

It is probable that in the average station, instrument cases and instrument-transformer secondaries are carefully earthed, but can this be said of the instrument-transformer frames? As every electrical worker knows, either by experience or hearsay, the secondary of an instrument transformer, when not earthed, is charged with static electricity at a potential dependent upon that of the primary circuit, which makes the instrument wiring unpleasant to touch, not to say dangerous. This condition is due, not to any electrical connection between the primary and secondary windings, but to the condenser effect of the primary circuit on the secondary.

This static charge is easily disposed of by earthing the secondary circuit. However, this leaves the metallic frame of the instrument transformer similarly charged, and if it is not positively earthed, this charge will seek earth by the path of least resistance.

The secondary windings of instrument transformers are insulated from the frame to withstand a test potential of a few hundred volts for one minute, but the potential of the charge on the frame is continuous and may be several thousand volts if the frame is not earthed. The path of least resistance for the charge if the frame is not earthed will be through this insulation to the secondary winding and then to earth.

Many construction men seem to think that instrument transformers, mounted on iron framework attached to the building frame or mounted on the building frame itself, have their frames sufficiently earthed. However, a loose or rusty joint or a bit of paint may easily make this path to earth of much higher resistance than that through the insulation to the secondary winding. This may damage the instrument transformer to such an extent as to cause a complete breakdown.

It is the writer's opinion, based on wide experience, that the only safe method for handling the earth connections for instrument-transformer frames is to install a thoroughly grounded earth bus and positively connect each instrument-transformer frame to it. The instrument-transformer secondaries may be connected to this bus also.

To insure full protection of the switchboard, an earth bus should be placed there, to which the instrument wiring and instrument cases should be connected. This bus and the instrument-transformer bus should be connected separately to the earth pipes or plates in order to obtain maximum protection.

Figs. 4, 5 and 6 afford an interesting illustration of what can happen to an instrument transformer although an excellent earth connection to the case had apparently been made. In this instance the potential transformer failed and one of the protective fuses of the inclosed type, located in the upper compartment, Fig. 4, did not open the primary circuit. The arc held between the fuse terminals, heating the porcelain supports to breakdown temperature, and caused an explosion in the compartment.

The side of the potential-transformer case to which the earth connection *E*, Fig. 5, was attached was blown off. When this occurred, the high-tension current jumped to the secondary wiring and burned it out all the way to the switchboard panel. It can be seen that the secondary-wiring fuse *S* has been blown to pieces. On the right-hand side in the foreground on the floor is a brass cap and piece of fiber tubing *F* and *F*, all that remained of the inclosed high-tension fuse. The cap of the condulet on the secondary wiring was also blown off.

The force of the explosion was so great that the doors of the compartment, which were locked shut, were blown to pieces, the larger pieces striking the wall twenty feet distant, as in Fig. 6, which shows a general view of the scene immediately after the trouble occurred.

All the occurrences narrated happened with startling rapidity; in fact, if one had been watching the accident, the sequence of the events could not have been determined by the eye. The circuit was cleared in less than one-half second after the trouble started.

After a thorough investigation of this trouble, it was decided to earth these potential-transformer cases at two points instead of one; the result is that no serious trouble has been experienced with this class of equipment on feeders since this was done, although one or two have failed.

In conclusion it may be said that the various classes of arresters and other equipment must have separate and independent connections to the earth pipes or plates.

Frames of various types of machines should be earthed independently wherever possible.

It is as essential to earth the frames of instrument transformers as it is to earth the secondary windings. Unless these frames are earthed, the instrument transformers are liable to breakdown.

The negative bus of a railway system must not be used as an earth connection.

Many cases of trouble that appear mysterious at first glance may be traced to the absence of an earth connection, due either to carelessness or accident.

Earth connections are as essential for the building frame and the frames of all equipment in the station as any other part of the wiring, as no installation of above 500 volts can safely be operated without them.

The construction engineer should watch the earth connections to see that they are properly made. When the station is put in operation, the operating superintendent should see that they are kept in first-class condition.

Safe Load on I-Beam by Rule of Thumb

By John S. Carpenter

When installing new machinery or taking out old, it is often desirable to use a block and tackle. Such rigging must be attached to beams, which may usually be found around power plants and may be arranged so that they are directly over the load. In a case of this kind it is desirable to know just what safe load may be put on the beam. A rule of thumb that will give this information is as follows:

Multiply the weight per foot of the I-beam by the depth in inches and divide the product by the span in feet. The result is the safe load in thousands of pounds for a uniformly distributed load. For a single load in the center of the span, take half the foregoing result.

To the writer, who has always figured beams by the usual bending-moment formulas, this rule did not sound right. It seemed too good to be true. So he determined to prove it to his own satisfaction. Let

W = Safe uniform load in pounds;
L = Span in feet;
S = Section modulus;
s = Safe stress, 16,000 lb. per sq.in.;
w = Weight of beam per foot;
d = Depth of beam in inches.

According to the rule, then, $W = \frac{1000\ wd}{L}$. But for a beam uniformly loaded, the safe load is $W = \frac{8Ss}{12L}$. Therefore, it follows that $\frac{8Ss}{12L} = \frac{1000\ wd}{L}$ or $8Ss = 12{,}000wd$, from which, letting $s = 16{,}000$, it is found that $S = 0.1067wd$. In other words, the section modulus is equal to the product of the weight of the beam per foot, the depth in inches, and a constant 0.1067. That this is approximately true may be ascertained by comparison with any steel manufacturer's catalog.

There were cases in which the writer did not know the weight per foot of the beam in question and so could not apply the rule. So he made up a table, as follows:

Depth of Beam, In.	Value of Constant	Depth of Beam, In.	Value of Constant
3	16,500	10	250,000
4	30,000	12	378,000
5	48,750	15	630,000
6	73,500	18	990,000
7	105,000	20	1,300,000
8	144,000	24	1,920,000
9	189,000		

To use the table in applying the rule, divide the constant opposite the depth of beam by twice the span in feet. The result is the safe load hung in the center of the span. For channels the safe load is half that for an I-beam of the same size. The resulting safe loads found by the foregoing constants will differ by only 5 or 6 per cent. from the actual safe loads.

Some Features of Low-Compression Oil Engines—V

By L. H. MORRISON

The fuel-injection pump is an important detail of the low-compression oil engine. This installment describes several forms of pumps and nozzles and gives information concerning their care and repair.

THE design of fuel pump used on the Fairbanks-Morse vertical engine is shown by the sectional view, Fig. 1. This particular pump is intended to be used on a three-cylinder engine; consequently, there is a complete pumping mechanism for each cylinder. The entire pump is bolted to a cast-iron housing, which in turn is bolted to the housing of the crankshaft bearing.

The action of the pump is as follows: The cam *A* is keyed to the crankshaft and has a low part that covers about 90 deg. of the cam circumference. This cam acts on the roller *B* and gives a reciprocating motion to the pump plunger *C*. The second cam *D* is keyed to a bushing, or quill, that is connected to the governor by suitable rods and that is free to turn on the crankshaft under the action of the governor. The two cams are so arranged that when the plunger *C* is at the inner end of its stroke, the cam *D* has opened the suction valve slightly by moving the push-rod *E* through the medium of the bell-crank lever *F*.

The section of one pump, shown in Fig. 2, will serve to make the action more easily understood. When the plunger *C* moves on its suction stroke, the suction

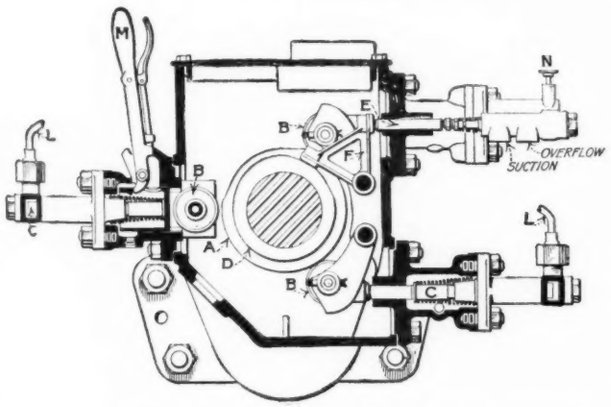


FIG. 1. FUEL PUMP OF FAIRBANKS-MORSE ENGINE

valve *G* is opened by the pressure of the oil, which overcomes the pressure of the light spring *H*, and the oil flows into the pump chamber *I*. When the high part of the cam *A*, Fig. 1, starts the plunger *C* on its discharge stroke, the suction valve is held open by the cam *D*. But when the low part of the cam *D* registers with the push-rod *E*, Fig. 2, the tappet rod *J* is forced outward by the spring *K* and the suction valve is closed by the spring *H*. The remaining oil in front of the plunger *C*, being unable to escape back through the suction valve, is forced out through the discharge valve and thence through the pipe *L*, Fig. 1, to the cylinder. Thus, the amount of fuel oil pumped to a cylinder is determined by the time of closing of the suction valve, which is under the control of the governor.

The linkage connecting the movable cam to the governor is arranged in such a manner that when the

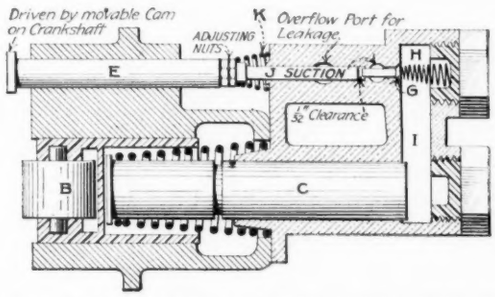


FIG. 2. ARRANGEMENT OF FAIRBANKS-MORSE FUEL PUMP

engine speed falls, the movable cam *D* advances with respect to the fixed cam *A*, thereby allowing the suction valve to close earlier. This, of course, gives the engine a greater fuel charge and increases the speed.

Attention is called to the starting lever *M*, Fig. 1, which is fulcrumed on the pump housing and in starting is used to pump the fuel by hand to one cylinder. A few strokes usually fill the discharge pipe. When this is accomplished the handle is set at its neutral point. In stopping a single-cylinder engine, the lever is used to pull the plunger out of contact with the cam *A*.

Another important detail is the bypass valve *N*. Usually, in starting, the engine has a tendency to take too heavy fuel charges, because the governor is at its lowest point and the movable cam *D* at its most advanced point, so that practically all the fuel entering the pump chamber must pass out through the discharge valve into the fuel nozzle. To eliminate this objection, the needle valve *N* is provided. In starting, the operator opens the valve a slight amount, thus allowing part of the charge to flow back into the suction line. Usually, when the engine runs only partly loaded, it is advisable to "crack" the valve and bypass part of the oil. This causes the governor to advance the cam so that the charge is forced into the cylinder earlier than when the bypass is not used. The result is a greater time for the fuel to burn, and better combustion is obtained.

Probably the average operator of a multicylinder engine is bewildered by the many links and levers shown. It does constitute an objection to have too many parts when only ordinary care is available. In this pump the links are amply strong, and the only wear is in the pins, which can be renewed at some expense and considerable labor.

It is probable that the greatest wear occurs on the movable cam, because it receives a considerable blow

each time it strikes the suction-valve push-rod. These hammer blows tend to wear a groove in the cam at the point of initial contact. After this develops, the push-rod, on striking the groove, rebounds and produces a series of grooves on the cam surface. This action can be eliminated by the use of a carbon-steel cam case-hardened to a depth of about $\frac{1}{8}$ in. after being ground.

The suction valve and the discharge valve are of the poppet type, and in regrinding them the utmost care must be exercised. It is unnecessary to grind the valve so that the entire seat is in perfect contact. A line contact $\frac{1}{64}$ in. or less in width is very satisfactory and will usually be better than a poor job of grinding the entire face into contact. While the erecting engineer may instruct the operator to use powdered glass as the grinding medium, a fine grade of emery flour and oil has made an excellent job on numerous occasions.

Where heavy fuel or boiler oil is used unfiltered, the grit carried with the oil will cut the pump valves rather rapidly. Ordinarily, such oil is thick enough to be sluggish about leaking past the valves. However, if a change is made to an oil of a lighter gravity, such as distillate oil or desulphurized Diesel fuel oil, the valves will leak badly, since the latter fuel will get by a valve showing the slightest ridge or rough spot on its face. If, after making a change in the oil, the engine seems to lose power, do not blame the new oil, but look at the condition of the pump valves.

If the engine is of fair size—above 100 hp.—and the lower cost of the unfiltered fuel oil is attractive, the operator should prepare to meet these valve leaks. It is a good plan to procure a valve-seat reamer, so that the seat may be brought back to its proper shape when badly scored. Since the valve seat is of brass, a reamer of ordinary steel slightly hardened will do

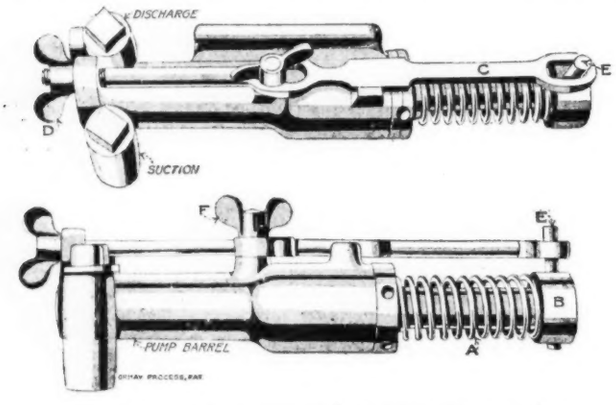


FIG. 3. FUEL PUMP OF MUNCIE OIL ENGINE

good work. The reamer should be in the shape of a cone with a number of cutting edges or notches, and the sides of the cone should have a 45-deg. slope to conform to the angle of the valve seat.

After regrinding or reaming a valve, it is necessary to adjust the outer end of the valve plunger or tappet rod so that the push-rod can be brought up against the cam when the valve is in a closed position.

The fuel pump used on the Muncie oil engine is shown in Fig. 3. The amount of oil injected by this pump is controlled by the length of stroke of the plunger. The spring *A* is seated against a collar *B* on the pump plunger and serves to move the plunger on the outward or suction stroke. The eccentric push-rod, controlled by the governor, actuates the plunger on the discharge stroke. The shaft governor changes the throw of the eccentric and consequently the pump-plunger movement, thus giving the required speed regulation.

This pump is provided with a hand-controlled speed-changing device mounted on the body of the pump.

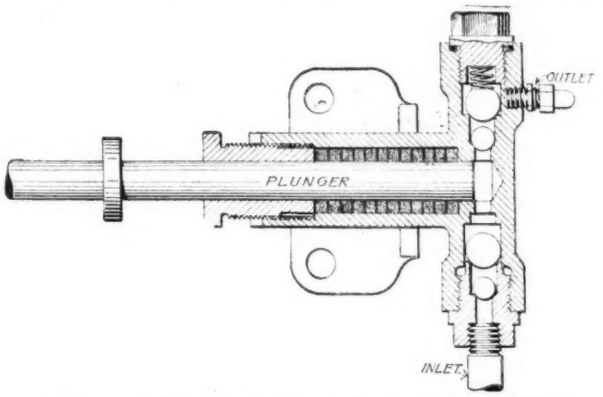


FIG. 4. FUEL PUMP OF LITTLE GIANT ENGINE

It consists of a link *C* which is threaded at one end to receive a wing-nut *D* and which is slotted at the other end to engage a pin *E* on the pump plunger. If it is desired to lower the speed, the wing-nut is screwed up, shortening the link and lessening the outward movement of the plunger. The link is provided with a locknut *F* that serves to hold the link in the desired position. By using this adjustment the plunger travel can be reduced until practically no oil is injected into the engine, so that an excellent speed control is obtained. The pump is simple in design and requires but little attention, but probably some degree of fuel control has been sacrificed in obtaining this simplicity.

Fig. 4 is a cross-section of the pump used on the Little Giant engine. It is fitted with a packed plunger and ball valves.

Fig. 5 shows the pump used on the Bessemer oil engine. Its important feature is the mechanical control of both suction and discharge valves. In the section shown, *A* is the pump plunger. The suction valve *B* is a wing-type poppet valve made of steel, as is also the discharge valve *C*.

The method of operation is rather unusual. The pump plunger is controlled by the shaft governor, which alters the pump stroke, thus regulating the amount of oil pumped. The valve rod *D* has one end in contact with a fixed cam on the engine shaft. This cam has a low spot extending over about 30 deg. of its surface. The result is that the rod *D*, through the bell-crank lever *E*, holds the suction valve open and the discharge valve closed through approximately 330 deg. of rotation of the shaft. Consequently, the oil drawn in by the pump is discharged back through the suction valve. When the low spot on the cam registers with the end of the valve push-rod *D*, the valve spindle *F* moves upward. This takes the pressure off the discharge valve *C* and the stem of the suction valve *B*. The two suction-valve springs immediately close the suction valve, and the upward movement of its valve stem pushes the discharge valve open. A small amount of oil then is forced out through the discharge valve. As soon as the low spot on the cam is passed, the dis-

charge valve is forced shut and the suction valve is opened.

Since the stroke of the pump varies with the load, the amount of oil forced into the discharge line depends on the amount of oil handled by the plunger. The discharge valve is always open when the pump completes its stroke; only on an overload would the oil still be discharging into the fuel nozzle when the can

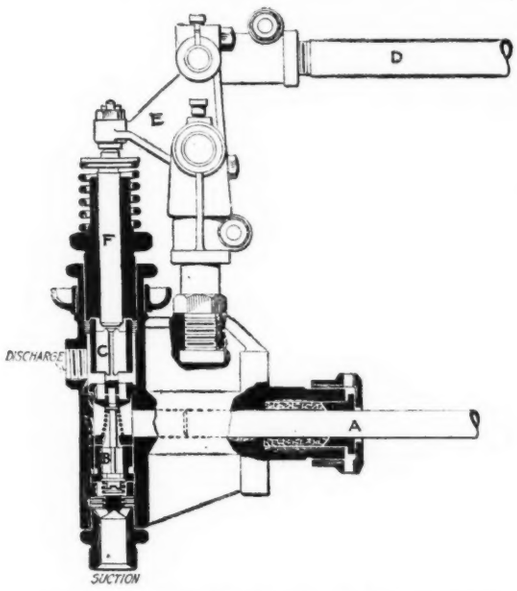


FIG. 5. FUEL PUMP OF BESSEMER ENGINE

closes the discharge valve. It naturally follows that the engine cannot carry very much of an overload without danger of preignition; because, if the low surface is made long enough to open the discharge valve in time to receive a heavy fuel charge, the point of opening is so early in the stroke of the engine that the early portion of the charge will preignite.

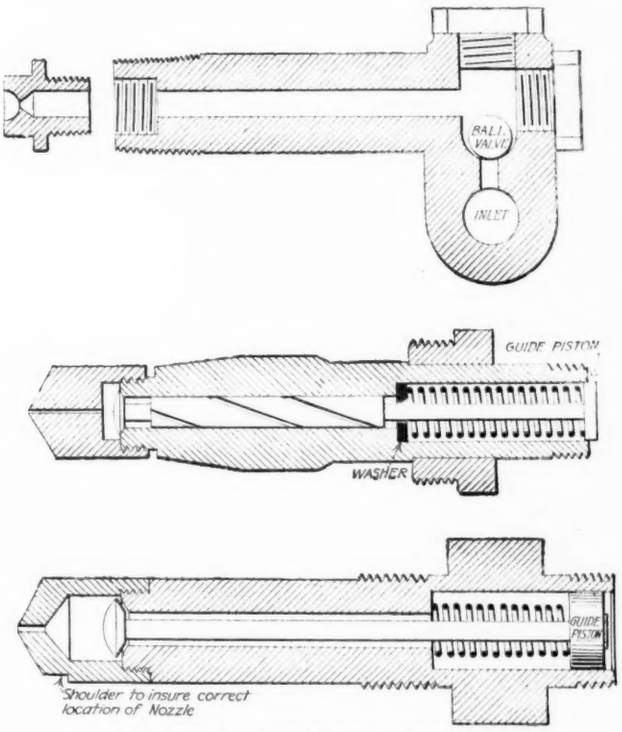
With this type of pump special attention should be given to both the suction and discharge valves. Owing to the hammer blow in closing, the valve seats require frequent regrinding. The pump has the very important advantage of causing the fuel injection to begin at the same piston position at all loads. This advantage over the ordinary plunger pump offsets the disadvantage of regrinding.

In all injection pumps the chief points requiring attention are the plungers and the valves. The plunger usually is ground to size, and this is depended upon to prevent leakage. It is impossible to prevent oil from leaking past the plunger, after the engine is worn. The only remedy is to ream the pump barrel and grind a new plunger to fit the new bore. If the pump is packed with fibrous packing, some care must be used to see that just enough pressure is put on the gland to prevent leakage. Frequently the pressure is so great as to prevent the plunger from returning to its outward position.

Pump valves are delicate affairs and should be carefully handled. When poppet valves are used, grinding must be performed with the greatest of care. A line contact between valve and seat should be maintained; also, the valve lift should not be more than $\frac{1}{32}$ in. If the lift is greater, the valve will not reseat quickly enough on the return stroke of the pump. When an engine operates at 250 r.p.m., while the injection of fuel is carried on for a period of 30 deg. in each revolution, it is evident that the interval of injection amounts to one-fiftieth of a second. The time used by the valves in closing must necessarily be much less.

When ball valves are used, reseating may be done by placing a hardwood stick against the ball and striking a light blow. The chief objection to a ball valve is that the ball must be perfectly spherical. A minute flat or rough spot on it may come in contact with the seat, allowing the oil to leak back. On the other hand, if the engine is in the care of an unskilled workman who cannot do a good grinding job, a ball valve is the better.

All fuel nozzles used on low-compression engines show much similarity of design. Figs. 6 to 8 show sectional views of typical nozzles. Unlike the Diesel nozzle, there is but little attempt to break the oil stream into a spray before it issues from the nozzle. All



FIGS. 6 TO 8. TYPES OF FUEL NOZZLES

use nozzle tips with one or two small openings through which the oil passes. As the engine is a vaporizing engine, it is not necessary to spray the oil, though much better results will occur if the oil is sprayed.

In the nozzle, as in the pump, a quick-closing and absolutely tight valve is necessary. Many of the poor economy records of this type of oil engine are due to the nozzle valve. Closing, as it does, during an infinitesimal fraction of a second, it is impossible to prevent a few drops of oil from getting by the valve as it closes.

As to the efficiency of the nozzle, much depends upon its location in the cylinder or combustion-chamber walls. If the nozzle is in a vertical position, opening upward into the cylinder, practically no drops of oil will enter the cylinder after the valve cuts off. On the other hand, the oil remaining in the nozzle tip, above the valve, will tend to vaporize, and if it is a heavy oil

it will leave a tarry residue which will choke up the nozzle tip.

If the nozzle opens downward into the cylinder, it will clear itself of all excess oil, resulting in a fairly open nozzle tip. But this position allows the excess oil to drip into the cylinder. If the pump and nozzle valves leak, oil will drip during the entire stroke. When placed horizontally in the head or combustion-chamber walls, the nozzle seems to operate best.

A spare nozzle should always be kept on hand. In regrinding the valve and seat, use emery flour and oil. Remove the valve spring and use no pressure on the valve beyond the weight of the valve and valve wrench. If pressure is exerted, the valve and seat will tend to grind smooth only in spots. To clean the nozzle tip, soak it a day or so in lye water; then sharpen a knitting needle, and use it to remove the softened asphaltum deposit from the tip opening.

Condensation Tests for the Plant

One of the most illuminating plant tests and still one of the easiest to conduct is the so-called "condensation test." The plant as a whole or any part of it, even a single engine unit that can be segregated, may be tested to determine the amount of heat lost through radiation. To test an idle engine's radiation loss, close the stop valve on the exhaust pipe (near the engine) or blank the exhaust and, with the engine in such a position that it will not start, open the throttle enough to keep the cylinder filled with steam at the working pressure. Arrange to collect, for a given time after the engine is thoroughly heated up, all the water that is formed by the condensation of the steam. Care should of course be taken to see that water does not flow from the steam-supply pipe or the test will not be fair to the engine and its immediate piping. On the other hand, if it is desired to include a system of piping in the test, all the drips from the piping must be included.

A similar test of a complete plant may sometimes be conducted with no great difficulty. The amount of condensate may be checked against the water fed into the boilers to maintain the water level. There is likely to be considerable discrepancy between the two, however, caused by numerous small steam leaks, considered unimportant, and also possibly some blowoff leakage. An overnight test of this kind, repeated enough times to be established as correct will "show up" the condition of things generally in a convincing manner. Surprises are apt to be in store for one who gives his plant or any part of it such a test for the first time.

Air Occluders for Use with Condensers

The successful development of the ejector type of air-removing apparatus within the last few years for use in connection with condensing equipment has been such that it is now recognized by the engineering profession as the best for this purpose. Its light weight, the small space occupied and its simplicity of operation, operating with a minimum amount of steam and freedom from possible breakdowns on account of absence of moving parts, make it particularly suitable for all work requiring a high degree of vacuum to be maintained.

The apparatus consists of two exhausters arranged in series, with an intercooler of either the surface or jet type placed between them. The latter type is shown in Fig. 1. The first exhauster, known as the primary

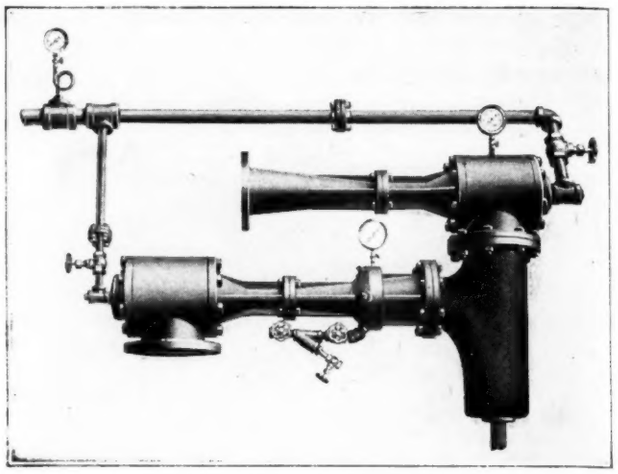


FIG. 1. ALBERGER CONDENSER IN OCCLUDER

nozzle, is connected to that part of the equipment from which the air and noncondensable vapors are to be removed, and is so constructed that the impelling steam

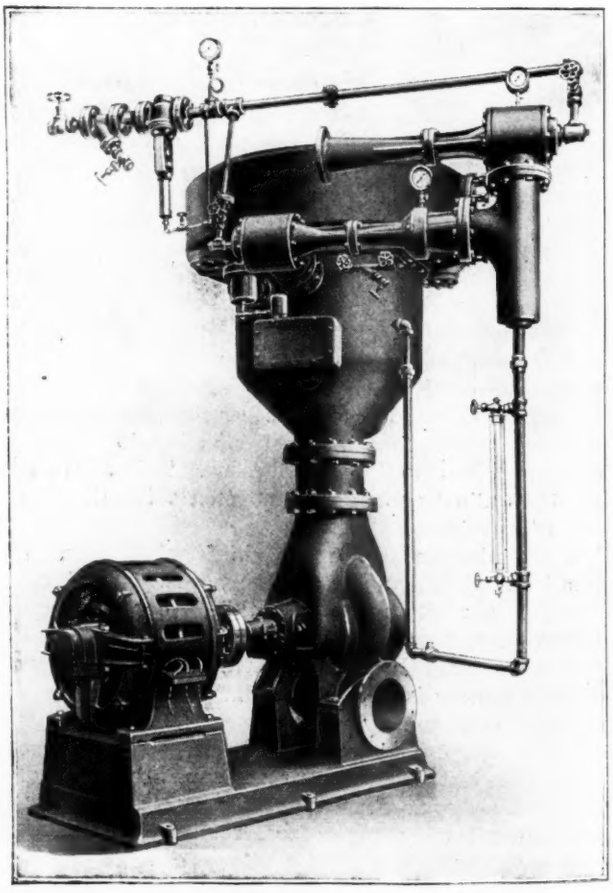


FIG. 2. AIR OCCLUDER WITH JET CONDENSER

entrains the air and noncondensable vapors and compresses them to the pressure existing in the intercooler.

The mixture of steam and ejected air and noncondensable vapors is then discharged into the inter-

cooler, which by condensing the steam and cooling the air and noncondensable vapors, reduces the volume to be handled by the final or secondary exhauster. This

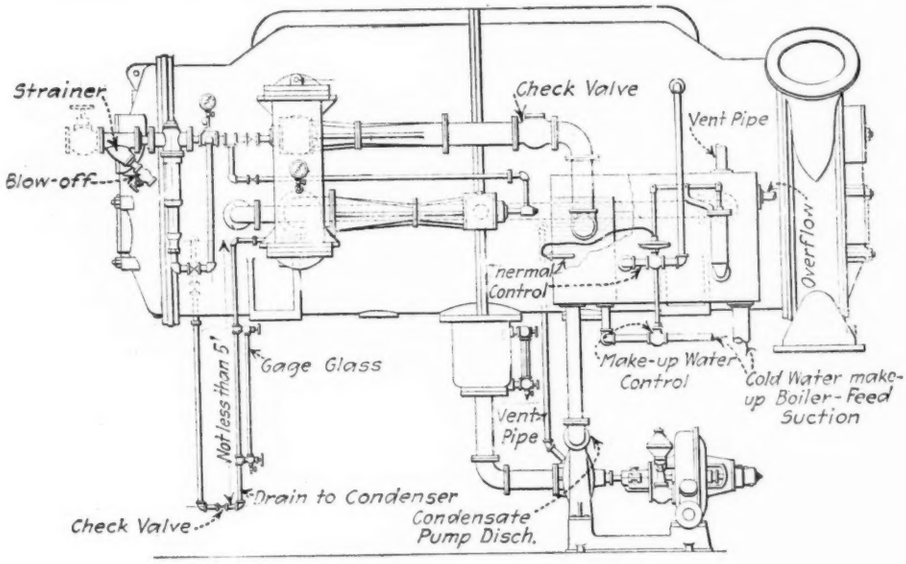


FIG. 3. AIR OCCLUDER WITH MARINE INSTALLATION

in turn reduces the amount of steam required for operating the secondary nozzle, permitting the handling of high ratios of compression, and as a result the quantity of steam required by the primary nozzle is relatively small. Without the intercooler the same quantity of air and noncondensable vapors would be handled, but a much larger quantity of steam would be necessary for operating the secondary exhauster. The quantity of intercooler water required is small and it can be utilized for boiler-feed makeup. The application of the occluder to a jet condenser is shown in Fig. 2.

For marine work or where other than fresh water is to be used for cooling, a surface intercooler is used,

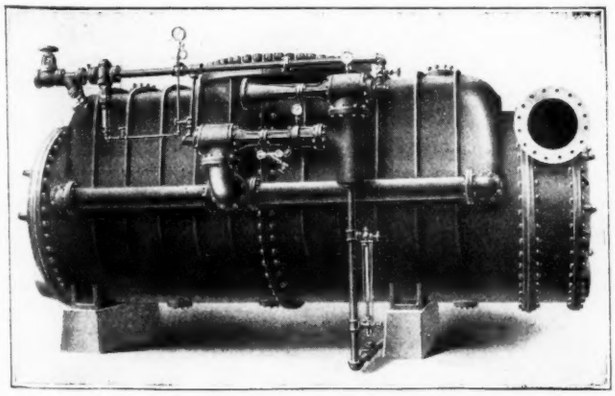


FIG. 4. AIR OCCLUDER, JET INTERCOOLER WITH SURFACE CONDENSER

thus permitting the use of sea water in this cooler and avoid mixing sea water with the steam used by the occluder. Fig. 3 shows the occluder as arranged for marine installation.

When used in connection with a surface condenser (See Fig. 4) provision must be made in the design of the condensate pump to handle the additional amount of cooling water necessary for the operation of a jet intercooler, although this item may be neglected if a surface intercooler is used. The temperature of the intercooler water should be the same as that used for condensing purposes. Each occluder is designed to operate under the normal boiler pressures obtaining, but are not offered for steam pressures below 140 lb. gage.

Two or more occluders may be attached to a single large condenser. This gives the greatest amount of flexibility in operation. For example, when starting up the main unit, two occluders can be used, permitting a quick start; after the vacuum has been obtained, one only need be operated unless there is an excessive amount of air to be handled.

The occluder is manufactured by the Alberger Pump and Condenser Co., 140 Cedar St., New York City. This apparatus is particularly suitable for marine work on account of its light weight, the small space occupied and its simplicity of operation.

Let's Keep Them on the Run

BY JOHN PRICE JONES
Assistant Director of Publicity

Now that we have 'em on the run, it must not be forgotten that a constant series of crushing blows is the only thing that the German can understand. To make these blows crash with full weight means men and metal, and men and metal mean money. There is plenty of patriotism "Over There" with Pershing, but the boys have to be fed and clothed and supplied with ammunition.

The Government of the United States is the best investment on the face of the earth. It never yet repudiated an obligation, and it never failed to pay the full rate of interest the moment it was due. Is there any other argument necessary to a man of business?

For three years we tried to keep out of this war, but now that we are in it, we are going to win it and win it gloriously. Therefore, come on into the front ranks with your dollars and help Uncle Sam buy for the millions of boys "Over There" the food and the clothing, the cannon and the ammunition that will bring the day of victory nearer.

There's no use dragging this thing out. Unless we get action, the Kaiser will fight on for years, dribbling along with what men and material he can commandeer. But, inasmuch as there is no question of our getting action, the day of doom for the imperial monster who brought untold suffering upon millions of human creatures is near at hand.

Let's make this Fourth Liberty Loan the biggest thing in all history. We have amazed not only the world, but ourselves, by the power we have shown when it was called upon; now let's show that all former activities were comparatively small and make this the great work of American men.

Watch the Auxiliaries

By P. R. Prescott

It is the duty of the engineer to obtain from every pound of coal all that is possible. To accomplish this it is necessary that more than the usual amount of attention should be given to the various power-plant auxiliaries. In the small and medium-sized plants, a greater part of the auxiliaries are direct-acting steam pumps, and unless the main units operate condensing, and all the steam consumed by the auxiliaries is condensed in a feed-water heater, there may occur a much greater loss than would be supposed.

It is well known that this type of pump consumes from 50 to 150 lb. of steam per horsepower-hour, and unless these pumps are kept in the pink of condition, the amount of steam consumed by them may be doubled. Assume that when the plant was new the amount of steam consumed by the auxiliaries was 8 per cent. of the total amount generated, and that after three years the amount required by them was 15 per cent. In this case the extra 7 per cent. would be a preventable loss and would amount to a large item in course of a year.

While auxiliaries as a rule receive little attention from the engineer, they should have the same care and attention as the main units. Too frequently condensers show but 20 to 22 in. of vacuum, with vacuum pumps running at high speed, when 24 to 26 in. could be attained, with the pumps running much slower. Feed pumps are also found struggling to supply the necessary water to the boilers, when at the same time the pumps are large enough to furnish the required amount at a much slower speed. These conditions not only result in a large waste, but increase the liability of breakdown. Pumps will frequently be found that have been operating for years with the pistons traveling but 60 to 80 per cent. of the normal stroke. This condition may be caused by packing too tight, or by improper valve setting. Frequently, the valve gear does not permit the pistons to make full travel. Such conditions result in shoulders being worn on the rods and in the cylinders, and a generally unsatisfactory performance is the result. Care should be taken that pumps are made to work full stroke. If the rods and valve stems are badly worn, they should be turned in a lathe, and a metal ring should be fitted to the bottom of the stuffing-box to prevent the packing from working into the cylinders. If these rings are carefully fitted, the packing may be left quite slack, the friction will be reduced, and the packing will last much longer. This also applies to outside-packed plungers, as the ring supporting the plunger prevents their sagging and at the same time prevents water getting to the packing so readily. The packing used on pumps should have considerable "life" and the glands should be left as loose as possible to prevent excessive friction.

If shoulders are worn in the steam cylinders and are not too bad, they may be removed with a scraper, or the cylinders may be rebored. If the piston is worn, turning it one-half turn may improve matters by raising the center. The packing rings should be examined and if there is any chance of leakage, new ones should be fitted. It will frequently happen, that while the rings fit the cylinder walls, they may be worn sufficiently to allow quite a space between the ends of the rings, and as the pump moves slowly this condition will result in excessive leakage.

With piston-type pumps it may be found that the linings of the water cylinders are badly worn. In this case it is better to secure new linings from the manufacturers. The old linings may be easily removed by splitting them lengthwise with a ripping chisel. On a small pump the new linings may be driven into place with a block of wood and hammer; on the larger sizes a jack may be necessary, but there is seldom trouble if the lining is inserted straight, and is of the proper size. It is better to draw-file the lining than to use too much force, as otherwise it may be damaged.

The steam valves on a pump that has been in use more than one year will usually need to be refitted to their seats. When doing this it is better to first fit valves to a true surface plate, and then scrape the valve seats to fit the valves. In cases of excessive wear the valve seats may require planing before attempting to apply a scraper, and in the latter case it is usually better to obtain new valves from the manufacturers, and then fit the old seats to the new valves.

The valves and seats in the water end of a pump need considerable attention if the pumps is to operate at its maximum efficiency. The seats should be refaced at least once a year if rubber valves are used, and oftener if metal valves are used. Metal valves should be turned in a lathe and then ground to their seats; hard-rubber valves may be refitted on a lathe or grinder to good advantage. Pumps will operate more satisfactorily and the steam consumption will be less if dry steam is supplied. If the steam line supplying the auxiliaries is acting as a drip from the main line, correction should be made. If the lines to the pumps are bare, they should be well insulated to prevent condensation.

Scene in Longueval village, once a beautiful French town, showing the result of German shells. This is a typical picture of the entire Somme fighting area. When you buy Liberty Bonds you put the power into the hands of the Allies to put an end to this. Buy bonds and more bouds. The more you buy the sooner Germany will be beaten and the sooner peace will come.

EDITORIALS

Convention of National Association of Stationary Engineers

PERHAPS none of the thirty-six annual conventions of the National Association of Stationary Engineers was more fraught with serious, progressive thought and work than that recently held at Cincinnati. There has always been an appreciation on the part of the delegates of the growing responsibilities of the power-plant engineer; but this year that appreciation was keen, broad and stimulating. Every man went to the convention feeling that this was a portentous year; every man came away knowing it was and that the year to come has its full share of problems to be met.

The get-together meeting of the convention and the heads of the United States Fuel Administration, the frank laying of cards on the table by Mr. Noyes and Mr. Myers stimulated and assured the association as nothing else could have done. With determined emphasis Mr. Myers, advisory engineer of the Fuel Administration, assured the convention that wherever the isolated plant could justify its existence it would continue to operate. The central station and the isolated plant alike will receive fair treatment at the hands of the Fuel Administration.

The papers on fuel utilization by Henry Misostow, recently of the Smoke Inspection Department of Chicago, and others, were of the best which the association has ever had presented to it. It is not so much that these papers are of excellent quality that they are interesting; it is that they were presented at all that makes them noteworthy in association affairs. Few papers have been presented before the association conventions, and for this reason the live interest shown in them is encouraging.

The attendance was, of course, smaller than in previous years owing to war conditions; this was also true of the mechanical exhibit. But what was lacking in numbers was made up by the keen interest of those present.

The presidency of the association went to Roderick Mackay, who distinguished himself in the building of the great aqueduct at Los Angeles, California. His experience here and abroad on the famous Clyde should well fit him for the duties of the chief executive of the association. In John J. Calahan, elected vice president, he has an aggressive, competent colleague.

The Fourth Liberty Loan

WHEN the American forces began to arrive in numbers on the soil of France, they represented an unknown and untried element in the world conflict. They had been given a rigorous course of training, it is true, but with the actual conditions of real warfare they had had no experience. Yet the confidence of the entire nation went with them. There was no doubt among those at home that these green soldiers, swept together in a few months from a population devoted to peaceful pursuits and unmilitaristic in thought and upbringing, would maintain all the splendid traditions of a brave and free people. The troops themselves were animated by the same spirit of confidence, yet they were devoid of conceit or braggadocio. They sensed the deadly seriousness of their task, but they entertained no fears or misgivings as to the outcome.

Germany, affecting an air of unconcern that she was far from feeling, made sneering remarks calculated subtly to express contempt and disregard of these untested forces. Even our Allies, fighting with their backs to the wall, were in the dark as to the quality of the men hurrying to their aid. They hoped with a hope that was almost a prayer, but they kept on fighting.

Then came the summer with its swift turning of the tables, changing the whole aspect of the struggle. For America's raw troops, fighting shoulder to shoulder with their Allies, justified all the hopes that had been reposed in them, confirmed the loyal confidence of the nation that bred them and established themselves as the superiors of the best that generations of Prussianism could muster against them. Chateau-Thierry, Belleau Wood, La Chapelle—names to conjure with, names that will glow on the pages of American history—taught the Hun the true significance of "unbeatable," an appellation he had hitherto reserved and appropriated to himself. And finally came the climactic news of the obliteration of the Saint-Mihiel salient, prepared for and executed by an American army acting as a unit under the command of its own officers.

The official communiqués and the unofficial accounts of the fighting make a wonderfully inspiring and thrilling story. But it is well to remember that such victories do not come by accident. They are the logical outcome of weeks of planning and preparation. The actual fighting is but the culmination of a series of coördinated actions that stretch back to the base of supplies, to the transport ships, across three thousand miles of treacherous ocean to the cantonments, the shops and the factories, and beyond and behind them to the millions of workers whose labor and wealth form the backbone of the whole gigantic enterprise. In brief, the success of our army on the other side is built, months in advance, on the pocketbooks of our people.

We are approaching the launching of a fourth great loan to provide the funds with which to carry on our colossal work. But this fourth appeal comes with a new and different force from those that have preceded it. The American army has found itself. It knows its power and its limitations and the knowledge has strengthened and steadied it. There is no more speculation or uncertainty. Every eye is turned to the northeast and before long the reports will cease to speak of devastated French villages and will begin to list the capture of towns with distinctive German names. The war is going to be carried into the enemy's

territory. The march across the frontier may be begun even before these lines are printed. An Allied victory is in the air.

This, then, is the situation at the moment the fourth war loan is announced: The Allies, stronger in spirit and numbers than ever before, welded into a unified force under the command of a master tactician, fighting with a courage and a determination that cannot be surpassed, are driving the enemy back from one vantage point to another with relentless pressure.

It is to sustain our part in this movement that the Government is asking the American people for six billions of dollars during the period from Sept. 28 to Oct. 19. It is the largest single sum asked for in the history of a war that can be described only in superlatives. But it is necessary for the attainment of our just aims. Its prompt subscription will make possible the execution of the plans now forming or already formulated by those who control the movements of our overseas troops. By the same token, failure to meet this obligation to the full would correspondingly hamper our military operations on the Western front.

We have only begun to fight in this war. All that has gone before has been the important and necessary work of laying a foundation for the very sort of effort that is now yielding such gratifying results in the region southwest of Metz. Our war-making machine has just begun to function rapidly and smoothly. Now is the time of all times to exert our supreme force in men, materials and money. The enemy is executing a series of enforced retreats. He is harassed and frightened. His frantic and jesuitical overtures for peace reveal his state of mind.

The fourth loan may well prove to be the Victory Loan. But whether it does or not, it will enable our troops to carry the war into Germany and bring home to the diabolical Huns something of the terror and suffering they have inflicted on a peaceable and peace-loving world.

Six billions is a stupendous amount, but the self-denial necessary to accumulate that sum is a trifling price to pay for the overthrow of Prussianism.

What About Your Plant Rating?

SEVERAL weeks ago the United States Fuel Administration gave notice that all power plants would be inspected and receive a classified rating according to the efficiency shown in the conservation of coal. Ratings are to be based upon the answers to questions regarding the operation of the installed equipment, each question having a value depending upon its relative importance to the other questions. These ratings will be made by the administrative engineers in each state and will be based upon the report of the field inspectors who inspect plants of their particular district.

There can be no valid excuse for an engineer or plant owner not having his plant in good condition, as it is understood that notice will be given about sixty days prior to the inspector's first visit, when the questionnaires that have been sent out will be checked. This gives every plant owner a reasonable time in which to improve operating conditions.

The engineer who has answered the questionnaires according to the facts and who has made the changes recommended need not fear for the rating that will be given. In the event, however, that correct answers have not been given, with the result that proper recommendations cannot have been made, a plant is evidently destined to receive a low rating.

No engineer likes to admit that there are faults about his plant that can be and should be remedied. He is also averse to putting such faults in writing above his signature, and that is why there will probably be hundreds of engineers and owners who will receive a severe jolt when the inspectors arrive to check up the statements made in the questionnaires. In some instances the engineers know where the fault lies; in others it may be a case of ignorance, but whatever the reason, the plant will have to be in good operating condition in order to obtain a high rating.

It is likely that in some plants there is still time to get after existing faults and remedy them before the inspector arrives to gather data on which to make the rating of the plants. As we understand the situation, nothing radical is to be done in the way of alteration, although in some plants such measures would result in a decreased cost in operation and the expenditure of a few hundred dollars would result in the saving of many times the amount involved in the changes.

There are many things that the engineer can remedy without any inconvenience to the plant operation and which on the other hand would improve conditions; for instance, such items as cleaning out the combustion chamber; cleaning the heating surface of soot and scale; stopping up the air leaks through the boiler fittings; making tight the blowoff and safety valves; replacing defective grates and thus preventing the loss of coal in the ashpit; seeing that the furnace doors fit tightly against the boiler front. Furthermore, there are numerous other remedies for steam and fuel losses that the engineer knows should be made in the other plant, but often fails to see can be carried out to good advantage in his own.

Then there is the method of firing and the control of the draft. So much has been published regarding this particular phase of boiler-room operation that it would seem that every operator must be familiar with its importance, yet one can find hundreds of boiler plants where little or no attention is given to these two important features so necessary to the economical operation of the boilers.

The work the engineer has to do at this particular time is to get everything connected with the operation of his plant fixed, and the rating to be given by the Fuel Administration need not then be a matter of concern.

The army wants one hundred refrigerating operating engineers immediately for service in camps and cantonments; in addition forty exceptionally well qualified refrigerating engineers are wanted as superintendents of plants. These latter will be commissioned, the former will be privates, corporals and sergeants. If you are qualified and are in the draft, here is a chance to be inducted into the service and work where you can work best. Write now, giving full experience, age, etc., to Construction Division, M. & R. Branch, Room H-15, Seventh and B Streets N. W., Washington, D. C. We feel that many of our readers will respond.

CORRESPONDENCE

Observations on Current Discharge Across Gap

If the vibrating element of a small jump-spark coil is short-circuited and a spark gap provided for the secondary, and if the primary circuit is then slowly made and broken, a spark will jump the gap at the instant of break. This is due to the fact that the magnetic flux in the core is made to decrease from a maximum to zero, which induces a high voltage in the secondary windings. With a small coil the spark lasts only a very short interval of time, but with a large coil it will persist for an appreciable period.

This was illustrated very clearly in the case of a 10-kv.-a. 44,000-volt transformer. The secondary was provided with a quarter-inch spark gap, and four dry cells were connected in series to supply the primary current. By slowly making and breaking the primary circuit a spark would jump the gap. It was very perceptible that the spark continued to jump the gap a marked interval of time after breaking the primary circuit. This manifestation is due to the large amount of flux involved, making the time required for it to decrease from maximum to zero of considerable duration.

C. R. BEHRINGER.

Utica, N. Y.

Two Electric Alarm Devices

The type of vacuum alarm shown in Fig. 1 is suitable for any system using a recording gage. A mercury cup is set in the base of the instrument, as shown, with one

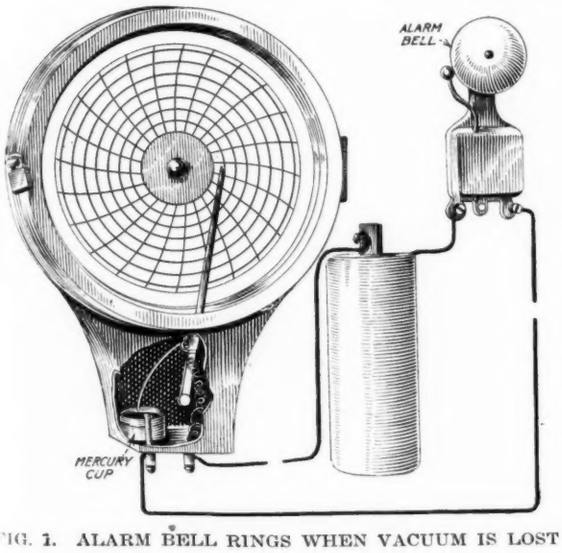


FIG. 1. ALARM BELL RINGS WHEN VACUUM IS LOST

lead from a battery connected to it. The other lead is connected to the pen arm. A wire is fastened to the pen arm and extends almost to the surface of the mercury when the vacuum is normal. Should the vacuum go down, the hand will move to the left and the wire entering the mercury will complete the circuit and the bell will ring. The wire from the arm to the cup may be bent to give the alarm at any desired pressure.

Fig. 2 shows an alarm used on a transformer air-blast

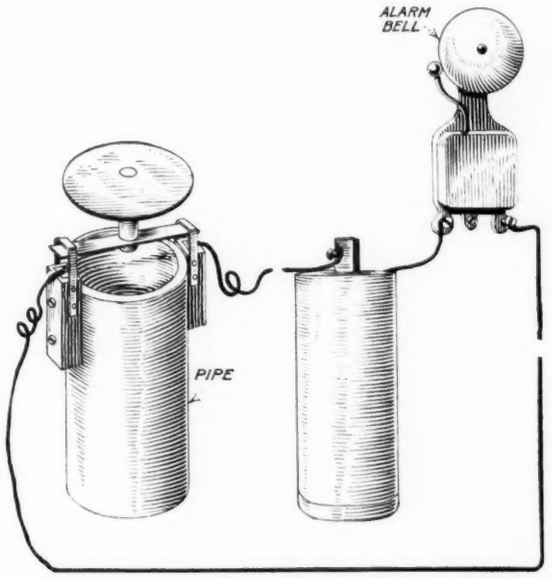


FIG. 2. BLAST FROM PIPE KEEPS BELL CIRCUIT OPEN

tunnel pipe. The air acting against plate *A* keeps it up, but if the air blast fails for any reason, the disk falls, completing the electric circuit and causing the alarm bell to ring.

WILLIAM H. WATSON.

Norristown, Penn.

Air Above the Fire

In the description of the Palmer forced-draft burner on page 387 of *Power* for Sept. 10 it is said "that no air enters the furnace from any other source," the source being the hollow grate bar. This seems to mean that all the air passes through the fuel bed.

I have read several times in *Power*, and in bulletins of the Bureau of Mines to which my attention has been directed by *Power*, that the necessary quantity of air for complete combustion cannot be gotten into the furnace by forcing it through the fire bed, because, while combustion does occur in the lower layers of the fire, the CO_2 thus produced is decomposed in the upper layers, taking up another atom of carbon and becoming CO when it is liberated from the surface of the fire. Unless air is admitted over the fire, this will go off unconsumed.

Of course, if the fire has holes in it, air enough can get through, but is it contemplated that the Palmer and similar furnaces shall be made effective by running a "holey" fire?

RALPH SNOW.

Chelsea, Mass.

Failure of Crossboxes in Water-Tube Boilers

An unusual defect in some water-tube boilers, and one having grave possibilities, came to my attention recently.

Some years ago a local inspector discovered a slight leak from the crossboxes at points *aa*, Fig. 1,

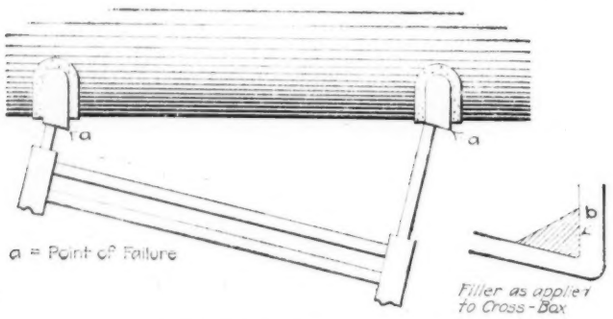
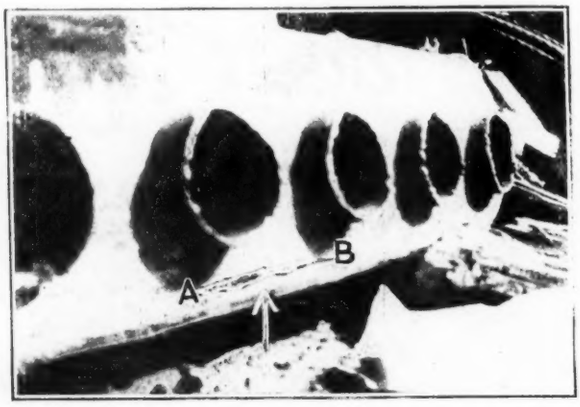


FIG. 1. CROSSBOXES OF WATER-TUBE BOILERS FAILED

and on close investigation it was found that the crossboxes were cracked at these points, not in one only, but in a number of boilers, and it was hard to determine just why they failed at this point. It was probably due to extreme and frequent expansion and contraction



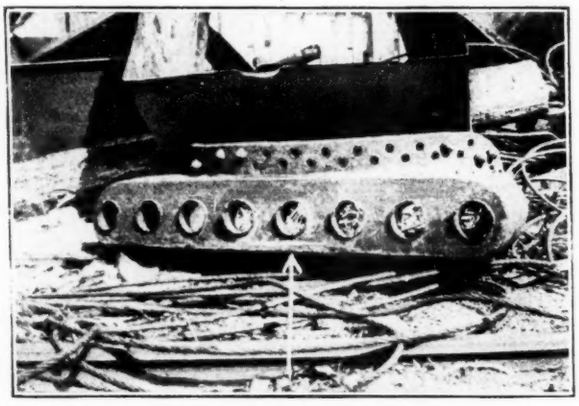


FIG. 2. CROSSBOXES PHOTOGRAPHED AFTER REMOVAL. PLUGGED AND WELDED PARTS INDICATED BY ARROWS

strains that in time caused crystallization or fatigue of the metal, with ultimate failure at the point where the most bending stress was set up; that is, at the turn of the box.

The first remedy suggested was drilling the crack and plugging, or stitching as it is commonly called. It was soon seen that this was unsatisfactory, as it was impossible to prevent the plugs from leaking, and in a short time the crack would extend beyond the plugged section.

Welding the crack was then tried. This welding process consisted of applying new metal on the inside of the box over the crack, as shown at *b*, but this also was unsatisfactory as when the parts are in tension there is a tendency for the crack to open at each such change of temperature in the firebox.

In the illustrations the cracks from *A* to *B* indicated by the arrows are shown plugged. The two crossboxes shown were removed and have been replaced by new ones of pressed steel. A. D. PALMER.

S. Quincy, Mass.

Methods of Testing Polarities of Circuits Without Voltmeter

It is sometimes required to determine the polarity of a circuit when no voltmeter is available, in which case one of the following methods will serve.

Take a glass of salt water and after connecting a lamp or two in circuit for resistance place the two wires in it. Bubbles will rise to the surface, and the wire at which the fewest of these bubbles are generated is the positive one.

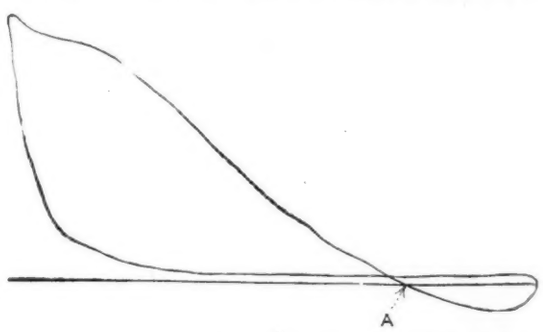
A small pocket compass may also be used as a polarity tester. Lay the wire so that it points north and south and place the compass over it. The needle will be deflected eastward if the current is flowing north and to the westward if the current is flowing south.

An ammeter may be used to test for direction of current if there is a plus sign on the instrument to indicate the polarity. WILLIAM H. WATSON.

Norristown, Penn.

Snifter Valves To Prevent Slamming

Referring to the item "Slamming of Corliss Valves," page 101 of July 16 issue, this trouble is most common when expansion goes below the pressure of the atmosphere, as shown at *A* in the diagram. The best remedy I have seen for this trouble, which is likely to occur with early cutoff, is to put ¾ in. check or snifter valves in the cylinder heads. When expansion goes slightly



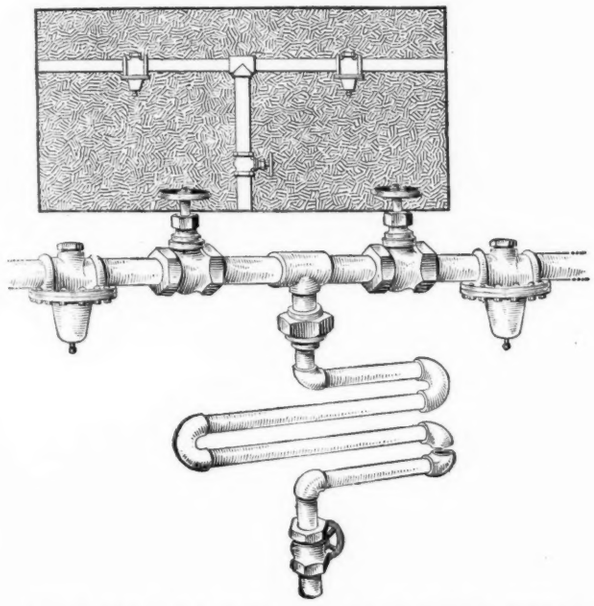
EXPANSION CARRIED BELOW ATMOSPHERIC PRESSURE

below atmospheric pressure these valves admit air to the cylinder, thus preventing the exhaust valves from being raised from their seats. JOHN M. COLEMAN.

Somerville, Mass.

Instantaneous Water Heater

An attempt was made to get hot water of uniform temperature by mixing steam and cold water by an arrangement of piping shown at the top in the illustration, in which two pressure-reducing valves, one for the steam and one for the water, were used to equalize the pressure, the heated water to be drawn off at the valve on the vertical pipe. This arrangement was not satisfactory because both the steam and water pressure varied considerably, and the



ADDED VALVES AND COIL MADE HEATER A SUCCESS

higher pressure on either one would hold the other valve closed. The only time a reasonable approach to the required mixture was obtained was when the valve was wide open, allowing the reducing valves to work to almost full capacity, but such a discharge was too great and the water splashed "all over." After considerable experimenting I worked out the arrangement shown in the lower part of the illustration by adding two globe valves and a small coil made up of short pieces of pipe joined with return bends to produce a thorough mixing effect. The globe valves were throttled down to pass just the right amount of water and steam, and the handwheels were then taken off. The arrangement gives the desired temperature without excessive pressure or flow when the valve below the coil is opened wide, and no further adjustment was required when the upper valves were once set.

R. MANLY ORR.

Vancouver, B. C., Canada.

Second Sight and Horse Sense

I read your interesting editorial, entitled "Second Sight and Horse Sense," on locating the cause producing certain effects or defects, which brought to mind an experience of mine many years ago.

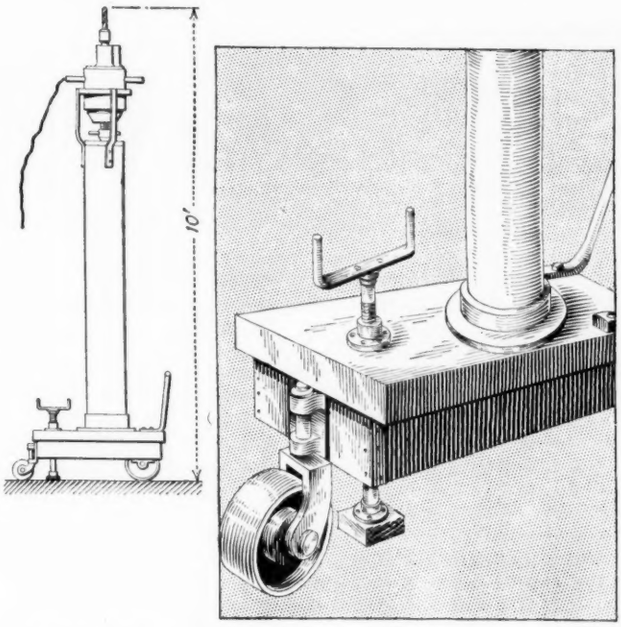
A certain mill in this city decided to change engineers, and on the recommendation of an engineer with whom I was acquainted, they made the change. The engine had a 12-in. cylinder and was of the old poppet-valve style, whose steam valves were operated by cams on a shaft running parallel with the cylinder. The cams lifted the valves by contact with adjustable rollers on the outer ends of the valve levers. Soon after the engineer started up the engine, it began to labor, but he found all journals cool. He then sent for his friend, who could not leave and asked me to go.

From a former experience I concluded that some of the machinery was consuming excessive power, but not until I got to the top floor and saw the exhaust did I find that the cause was in the engine. As there was no trouble before, I concluded the previous engineer had played a trick by slacking the piston springs, and I intended resetting them at noon. While waiting and watching, I noticed that the rollers on the valve levers turned continuously instead of being idle while the cams were revolving through the concentric portion. This convinced me that the former engineer had lowered the adjustable rollers just enough to prevent the valves from seating properly; hence I simply adjusted the rollers to clear the concentric portion of the cams while the engine was still running, and the job was done.

Philadelphia, Penn. WILLIAM S. LUCKENBACH.

Rig for Drilling Holes in Ceiling

Some time ago we had to move a large number of machine tools from the old "shop" to the new "factory," in which all the stringers intended to receive the countershafts were set into the concrete ceilings. This meant drilling a large number of holes for the lag-screws holding the crosspieces to which the counter-



DRILL MOUNTED IN VERTICAL POSITION ON TRUCK

shafts were fastened. We had a big electric drill weighing about 100 lb., and although we had a traveling platform, it meant a lot of hard work to set it up so that the holes in the stringers agreed with those in the crosspieces, so we rigged up the drill stand shown in the illustration. On the top of a small truck we fastened a piece of 6-in. pipe the right length for

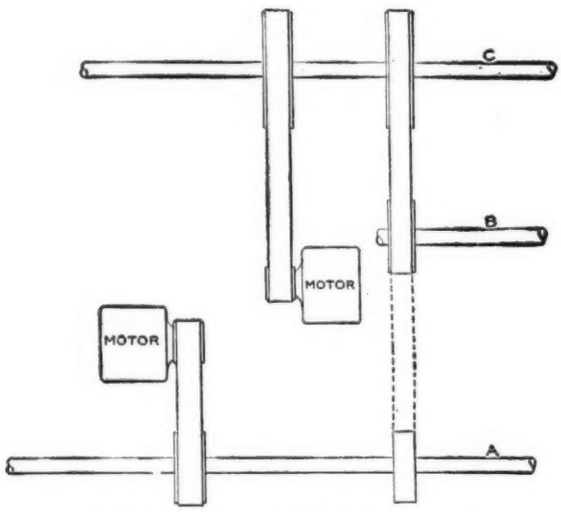
the drill to rest on top and just clear the ceiling. A cast-iron disk and a cage to keep the drill in place completed this part of the rig.

After trying the rig for a few holes, we found that the vibration had a tendency to make the truck creep, so we added a brake in the shape of a threaded piece of pipe running in a flange and carrying a wooden shoe at the bottom. The friction of the shoe on the concrete floor was sufficient to keep the truck where set.

Lynn, Mass. P. P. FENAUX.

Laying Out Lines of Shafting

It is a good plan in laying out lines of shafting, even when several lines are to be driven by different motors, to place them all parallel so that in case of necessity the drive may be changed from one motor or shaft to another. This can be easily done by establishing "station points" in the building from which every shaft should be located. In the layout illustrated, shaft *B* was originally driven from line *A* but, for some reason,



LAYOUT OF THREE LINES OF SHAFTING

was later driven from line *C*. *B* was probably parallel with *A*, but was not parallel with *C*, so that guides had to be used to keep the belt on. R. MCLAREN.

St. Catharines, Ont., Canada.

Broken Pliers Used as Pipe Cutter

A pair of side-cutting pliers had a piece broken out of the cutter in attempting to cut a piece of steel wire thought to be copper, but instead of being made entirely useless, as supposed, they were only shaped for greater service. When it became necessary to cut off a piece of ¼-in. brass pipe and no hacksaw or pipe cutter was available, the nick in the cutter, it was found, made a nice sharp-edged tool for the purpose, and by turning the pliers around the pipe and gripping them firmly at the same time a small chip was shaved out the same as with a lathe cutting tool. A few revolutions cut the pipe through with only a small burr left on the inside edge. With small tubing ⅛-in. or less even a hacksaw does not make a very neat job, but by putting a piece of soft iron or copper wire on the inside of the tube it can be cut off clean without mashing it flat and the full diameter of the inside of the pipe is preserved, there is no

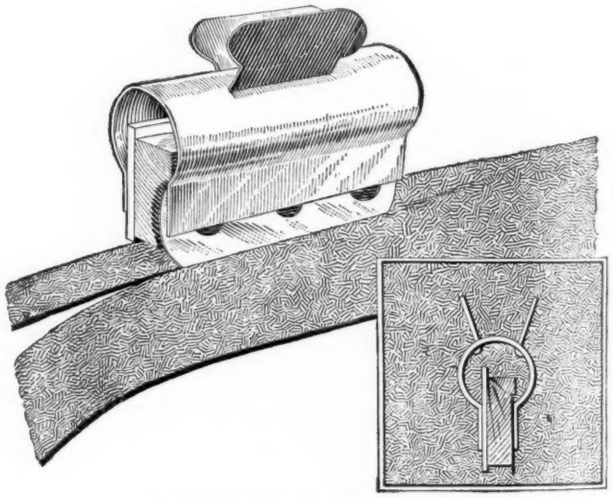
BROKEN WIRE CUTTER GOOD FOR PIPES

burr left on the inside and it does not require filing.

Cambridge, Mass. R. A. CULTRA.

Simple Lacing Cutter

The little lacing cutter shown herewith can be made in a few minutes for about five cents, the cost of one strong paper clip. Any make of a safety-razor blade that has become too dull for shaving can be used. If it is desired to cut belt lace ¼ or ⅜ in. wide, use a piece of wood of the thickness desired, also have a



HOME-MADE LACING CUTTER

piece of ⅛-in. band iron about 1½ in. wide and as long as the blade. Place them as shown, using the iron as a stop and the wood as a gage, and with the razor blade slightly raised at the head end cut the lace.

Portsmouth, Ont., Canada. JAMES E. NOBLE.

Why the Steam Whistle?

I wonder why the Fuel Administration does not request plant operators to reduce the length of factory-whistle blasts. In any manufacturing town, at approximately 7 and 12 o'clock each day, one hears whistles wasting steam—which is coal.

It seems to me that a short blast of a small whistle is just as effective for all practical purposes as half and minute blasts of more powerful whistles. Did you ever watch the steam gage when the whistle was blowing?

In these times when everybody has a watch or a clock, why is the factory whistle necessary or tolerated?

Akron, Ohio. A. A. BOWDOIN.

INQUIRIES OF GENERAL INTEREST

Joint of Piston Ring—To fill the order for a piston ring for a 22 x 42-in. Corliss engine supplied with steam at 165 lb. gage, the builders have supplied a ring with no lap at the joint which is simply of the butt type, without provision for holding the steam. Should not there be a lap or some kind of a keeper to make the joint tight? B. F. L.

It is assumed that a piston packing ring is referred to. Such rings should be fitted with a keeper, or a half-and-half cutout lap, to prevent steam from blowing through, or at least to retard leakage that would result in waste of steam and also to prevent scoring of the cylinder, in the same manner that grooves are formed by leakage and abrasion by a fracture of a piston ring.

Boiler Efficiency for Increased Capacity—When a boiler is fired above the usual rating of capacity, is there an increase or decrease in efficiency of the heating surface? J. L. L.

As the capacity is increased there generally is a decrease in the efficiency of the heating surfaces. But increase in capacity is usually accompanied by an increase in furnace efficiency and, within moderate capacities, the increase in furnace efficiency is usually at a greater rate than the decrease in boiler efficiency. Hence the combined efficiency generally increases at first with increase of capacity, and the point of maximum combined efficiency is at a capacity somewhat above the boiler's rated capacity.

Absolute Pressure in Condenser—When a vacuum gage in a condenser shows 27 in., what is the absolute pressure in the condenser in pounds per square inch if the barometer reading is 30 in.? F. C.

A vacuum gage reading of 27 in. would indicate that the condenser pressure was equivalent to 27 in. of mercury-column pressure less than the pressure of the atmosphere. Hence if the atmospheric pressure shown by the barometer is equal to a mercury-column pressure of 30 in., the absolute pressure in the condenser would be 30 — 27 = 3 in. of mercury-column pressure. At ordinary temperatures each inch of mercury-column pressure may be considered as equivalent to 0.491 lb. per sq.in., so that under the conditions stated the absolute pressure in the condenser would be 3 × 0.491 = 1.473 lb. per sq.in.

Steam Pipe Line for Engine—What size of steam line should be provided for a 250-hp. reciprocating engine? W. E.

The size to be used would depend on the length of the line and the allowable pressure drop. The diameter for an average steam line to an engine, when the line is not over 100 ft. long, is made up with the usual number of bends and fittings and is to be operated with a moderate drop in pressure, may be determined by the simple formula,

$$\textit{Pipe diameter in inches} = \sqrt{\textit{hp.} \div 6}$$

According to this formula a steam pipe line of moderate length for supplying a 250-hp. engine should have a diameter of $\sqrt{250 \div 6} = 6.45$ in., for which the smallest commercial size suitable would be 7-in. steam pipe.

Allowance for Quality of Steam Supplied Engine—In testing the economy of a 16 × 20-in. automatic engine whose consumption of steam at 100 lb. gage pressure is to be based on dry steam used per horsepower per hour, what allowance should be made for 7 per cent. of water contained in the steam that is supplied to the engine? F. M.

Entrained moisture undoubtedly has some effect on the expansive properties of steam, but by common consent it is customary to allow that the ill effect is proportional to the percentage of moisture present. Carefully conducted experiments on engine economies, with moistures varied from 1 to about 40 per cent., have shown that the consumption of dry steam per indicated horsepower per hour remains practically constant, indicating that the water present was an inert quantity doing neither good nor harm. Therefore with 7 per cent. of moisture in the steam supplied it would be fair to assume that the true water rate would be 93 per cent. of the weight of wet steam supplied.

Height of Return-Tubular Boiler Water Gages—What is the best method of determining whether the water gage of a return-tubular boiler is set at the proper height? H. R.

For a horizontal return-tubular boiler, the lowest gage-cock and the lowest visible part of a water glass should be not less than 2 in. above the upper surface of the highest fire tube. The very best method of determining whether a gage-glass or gage-cock is set at the proper height would be to observe its indication of the water level at a time when the boiler is cold, and the depth of the water above the highest tube is determined by actual measurement. Ordinarily, the relative height of the water gages and tubes can be determined with sufficient accuracy by carefully leveling from one to the other with a builder's level and leveling board.

Little Power Obtainable from Current Waterwheel—What would be the approximate number of horsepower derived from a waterwheel 16 ft. diameter by 14 ft. wide having blades or paddles dipping 2 ft. into the water and velocity of the stream 150 ft. per minute? E. T. L.

The best effect obtainable with waterwheels of the type described is about 40 per cent. of the energy of the water that is intercepted by the paddles. The weight of water presented would be (14 × 2 × 150 × 62.4) ÷ 60 = 4368 lb. per sec., and a velocity of 150 ft. per min. would be equivalent to 2.5 ft. per sec. The energy in the intercepted water would be

$$\frac{WV^2}{2g} = \frac{4368 \times (2.5)^2}{2 \times 32.16} = 424.44 \textit{ ft.-lb. per sec.}$$

or 424.44 ÷ 550 = 0.77 hp., and with 40 per cent. efficiency the net power developed would be only 0.308 of 1 hp.

Equivalent Evaporation with Superheated Steam—Having feed water at a temperature of 180 deg. F. made into steam at 175 lb. gage, superheated 125 deg. F., and evaporation of 14.2 lb. of feed water per pound of fuel oil, what would be the equivalent evaporation from and at 212 deg. F.? J. B. T.

According to Marks and Davis tables of the properties of superheated steam, a pound of steam at the pressure of 175 lb. per sq.in. gage, or 175 + 15 = 190 lb. absolute, when superheated 120 deg. F., contains 1266.1 B.t.u. above 32 deg. F., and when superheated 130 deg. F. contains 1271.2 B.t.u. From interpolation it may be considered that for 190 lb. absolute and 125 deg. superheat, a pound of steam contains 1268.6 B.t.u. above 32 deg. F. A pound of feed water at a temperature of 180 deg. F. may be considered to contain 180 — 32 = 148 B.t.u. above 32 deg. F., and under the conditions stated each pound of feed water for conversion into steam would need to receive 1268.6 — 148 = 1120.6 B.t.u. Evaporation of a pound of water from and at 212 deg. F. requires the latent heat of evaporation, namely, 970.4 B.t.u., so that each pound of the feed water evaporated under the actual conditions would be equivalent to the evaporation of 1120.6 ÷ 970.4 = 1.1548 lb. from and at 212 deg. F. With this factor of evaporation, the evaporation of 14.2 lb. of water per pound of fuel oil under actual conditions would be equivalent to evaporation of 14.2 × 1.1548 = 16.39 lb. of water from and at 212 deg. F. per pound of fuel oil.

[Correspondents sending in inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

National Convention N. A. S. E.

SEPT. 9-13 the National Association of Stationary Engineers held its thirty-sixth annual convention at Cincinnati, Ohio. Headquarters was at the Sinton and the transactions of the engineers and exhibitors were conducted in Music Hall. Although the attendance was lighter than usual, about 250 delegates being present, a new era was inaugurated in the conduct of the convention. Time given over to business and routine matters was limited. Reports were made in abstract and business matters were conducted with a minimum waste of time. Credit is to be given John A. Wickert, retiring president, for his efficient conduct in the chair and his untiring efforts for the good of the association during the last year. For the first time a reasonable proportion of the annual convention was given over to education, the watchword of the association. There were four excellent papers on topics of prime importance at present, a number of welfare talks and in addition an entire evening was given over to "Fuel Regulation and Conservation." The convention was a decided success and may well serve as a model to build on in the years to come.

With the preliminaries over on Monday, the convention was officially opened Tuesday morning, with R. W. Parry, chairman of the local committee, presiding. Welcome to the city was given by Mayor Galvin, who lauded the organization for its work in the conservation of fuel, saying that next to the fighting men engineers had done more for the successful prosecution of the war than any other individual unit of the army. Continued assistance to this end by placing the entire resources of the engineering profession at the disposal of the Government was urged by the Mayor.

In response President Wickert assured the Mayor that the engineers feel great responsibility in their part in the war, that everything possible was placed before members of the association to train and aid them in doing their work in the most efficient manner, that their services were at the disposal of the Government and will remain so until "Kaiserism" is stamped out of the world.

Roderick Mackay, national vice president, said that the organization was backing up the men in the trenches heart and soul and urged that everybody do all possible so that the Army and Navy will never lack the needed things.

Past President Kerley reviewed briefly the aims and objects of the N. A. S. E., showing that they all tended toward the conservation of fuel that the Government is now so strongly urging. Conservation in bulk could only be obtained by the efforts of intelligent and trained engineers. The N. A. S. E. had them, and he pointed out the possibilities awaiting them in the future.

S. B. Balmfirth, of Toronto, representing the Canadian Association of Stationary Engineers, conveyed a fraternal message from that body and as a token of brotherly love presented a Union Jack to the association. He explained the origin of the flag, which stands for freedom, honor and justice. The speaker reviewed the part Canada, and Toronto in particular, is taking in the war. Closer coöperation between the two associations was suggested. The speaker was here to get suggestions and the association he represented would be glad to do anything in their power to coöperate.

A service flag containing nearly 500 stars was dedicated, the address being given by Joseph O'Connell, who eulogized the members who had entered the war service. John Fehrenbach followed with a few remarks on the patriotism of the N. A. S. E. and its red, white and blue emblem. The organization could be likened to a great university in which steam engineering was taught. Since he had been president, 31 years ago, there had been great improvement in the rank and file of the membership. He was particularly glad to see that the educational feature of the association had been carried into the national convention in place of politics and needless waste of time in the conduct of business.

Upon assuming the chair President Wickert was presented with a handsome silver-mounted gavel by Charles Bindrich in behalf of Wisconsin No. 18, of Milwaukee. The convention committees were announced and a resolution adopted pledging anew to the President of the United States the loyal and patriotic support of the association.

The Tuesday afternoon session was devoted to official reports, a paper on "Illumination" and an address by Judson Pratt relating to the Life and Accident Insurance Department of the association. President Wickert covered fully the work done during the last year, referring incidentally to the loss of the publication suit involving a sum of $9,287.17. It was an off year for engineers' license legislation. The educational work had been splendid. The work of the regular educational committee had been supplemented by a Power Plant Cost Committee, which had inaugurated systems of records that would provide valuable information for the questionnaire. Recommendations were made calling for resolutions pledging loyalty to the President and the Government, coöpera-

tion with the Fuel Administration and an expression of best wishes to members at the front. The president recommended the purchase of additional Liberty Bonds, that all educational material available be used in preparation of a new N. A. S. E. "Questions and Answers" book, that the national president be authorized to secure more appropriate quarters for the national secretary, that the secretary receive an additional $600 for the extra service rendered the last year, that the associate editor's salary be raised to $2200, that the officers of the National Exhibitors' Association render the national secretary a detailed report of the business and the financial transactions on their part in connection with the convention, that the convention concur in the movement of the National Association of Purchasing Agents that provides for the standardizing of all catalogs, that greater precautions be exercised by subordinate associations in delegating power to act, upon committees or individual members. The recommendations were referred to the various committees and subsequently acted upon favorably by the convention. Reports of the national deputy, secretary and treasurer followed.

The Committee on Technical Papers recommended that lists of technical papers and welfare talks be prepared not later than Feb. 15 of each year and submitted to the national president for approval, the former to be published in the August number of the *National Engineer* and the latter in the May number to give time for written discussions. An appropriation of $100 for use by the committee was also recommended.

The Power Plant Costs Committee recommended that yearly costs be kept by members, that prizes be offered for the three best cost sheets submitted to the committee and that $200 be appropriated to defray the expenses of the committee.

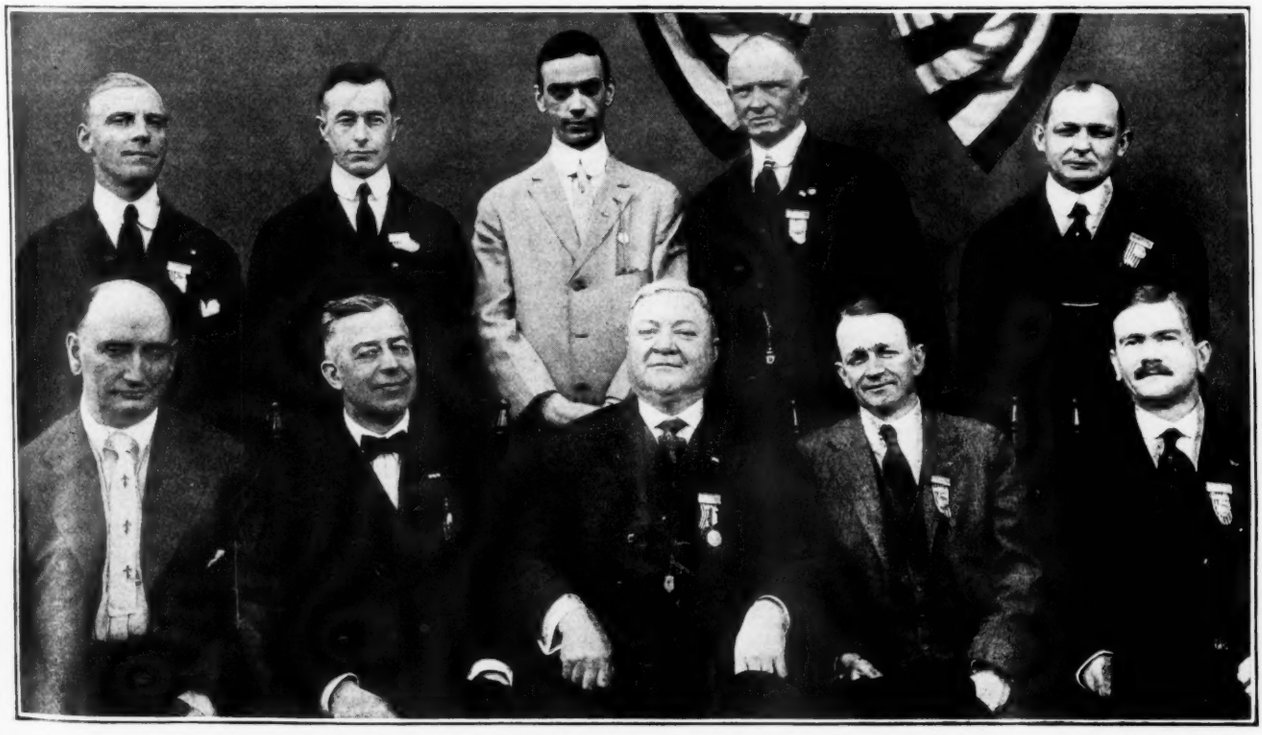
The License Committee recommended that the policy of establishing the headquarters of the license committee in the office of the national secretary be continued, that in the selection of the committee preference be given to members from states that have some chance of securing legislation, that the efforts of the committee be concentrated on not more than two states and that an appropriation of not less than $2000 be made to defray the expense of the License Committee. License work is not aggressive now.

The Educational Committee reported making a working arrangement with the Extension Department of the University of Wisconsin whereby any member could take up the work given in the engineering department and upon completion of a course receive a certificate. This committee recommended that the set of slides on gas and oil engines be brought up to date and a new lecture prepared and that authority be given to prepare a lecture and slides on "Fuel Conservation." An appropriation of $2000 was asked to be set aside for educational work of the association.

A paper by G. H. Stickney presenting practical suggestions on the lighting of industrial plants, office buildings and stores followed. The Life and Accident Department reported 73 claims amounting to $36,500. Membership had fallen off from 3463 to 3334 during the year.

Tuesday night the convention was addressed by P. B. Noyes, of the United States Fuel Administration, and David Moffat Myers, advisory engineer, who has in charge the questionnaire plan for increasing economy. An abstract of Mr. Noyes' address appears on page 471.

Mr. Myers urged the engineers to give their best efforts to fuel conservation, to keep the factories running, prevent accidents and to get results. He outlined briefly the working of the questionnaire and how administrative engineers for each state were putting the plan into operation. The speaker called attention to several important points to be considered in increasing the efficiency of the plant. It is not the purpose of the administration to play favorites between the isolated plant and the central station. It is simply a question of saving coal. An isolated plant using the greater proportion of its exhaust steam can use coal more efficiently at any time than the most ideal central station, but where the isolated plant wastes practically all the exhaust steam, as some did during the summer months, it is possible to save coal by purchasing current from the central station. The administration has adopted the policy of trying to have one or more members of the N. A. S. E. on the various administrative boards. These men will form the connecting links between the administration and the organization and tend to produce maximum results. The administration proposes to give everybody a square deal,



OFFICERS OF THE NATIONAL EXHIBITORS ASSOCIATION

Standing, left to right, Executive Committee—Hudson Dickerman, L. W. Brooks, Frank Martin, Horace Rand, W. L. Rogers. Seated, left to right—F. N. Chapman, treasurer; Thomas C. Green, secretary; Charles Cullen, president; Paul T. Payne, past president; Horace Smith, vice president.

all the cards are on the table where all can see them and all they want is the coöperation of all concerned. In the opinion of Mr. Myers the administration would be discontinued after the war, but the conservation program would continue in force in some form. In the discussion following attention was given to the merits of a bonus system and the value of measuring the coal and weighing the water. Every possible means should be taken to interest the fireman in getting the most efficient results. Royal H. Holbrook discussed the problems met in Iowa and how they had solved them. He told how they brought together the man who paid for the coal and the man who burned it. Their main efforts had been centered on covering pipes, eliminating steam leaks from the blowoff and the piping, making settings air-tight and keeping the heating surfaces clean.

Wednesday morning the important feature on the program was a paper by F. C. Ruck, on the "Commercial Value of Exhaust Steam in the Isolated Power Plant." Mr. Ruck had made an exhaustive study of the question in his own plant in Milwaukee and elsewhere and presented data of exceptional value. The paper and the discussion will be abstracted in an early issue.

Wednesday afternoon and evening the annual field day and outing was held at the Zoological Gardens under the auspices of the Lunkenheimer Co. The engineers were badly beaten in the ball game, but in the tug-of-war easily vanquished the exhibitors. Races and other field sports, open-air dancing and a band concert followed. A buffet supper was served at the club house and vaudeville entertainment completed a most enjoyable program.

Thursday morning's session was taken up by reports of committees and the Board of Trustees and a prolonged discussion on "Being an Efficient Officer." At 11:30 the National Ladies Auxiliary paid an official visit to the convention. The usual courtesies were exchanged and the ladies were $100 richer when they left. Annual memorial services ended the morning session.

On Thursday afternoon a long report by the Referendum Committee introduced a technical session of two papers. The first paper, by Henry Misostow, on "Generation of Heat from Bituminous Coal and Its Absorption by the Boiler," was received with a great deal of interest and resulted in animated discussion. An abstract will appear in an early issue. The second paper, by Thomas J. Royer, was devoted to "California Petroleum Oil as a Fuel." At the close of the session a pleasing incident was the presentation of a gold-headed cane to Henry D. Cozens, first national president, by "Dad" Beckerleg, the occasion being the 76th birthday of the recipient. The compliment was returned by Cozens and Mr. Beckerleg was presented with his third gold-headed cane. Both were agreeably surprised, to the merriment of the onlookers.

Entertainment under the auspices of the National Exhibitors' Association was the feature for Thursday evening. A pleasing program was rendered. Friday morning Fred Dornbrook gave the results of tests on a powdered-coal installation at the Oneida Street Station of the Milwaukee Electric Railway and Light Co. Complete data on this installation will appear in an early issue. The Ways and Means Committee submitted the following budget, which was adopted by the convention:

Mileage	$15,000.00
License committee	1,000.00
Educational committee	1,500.00
Power plant costs committee	200.00
Technical papers committee	100.00
Fourth Liberty Loan bond issue	1,000.00
National president, expense	1,000.00
Special deputies, expense	1,000.00
National deputy, expense	500.00
Associate editor, "National Engineer"	2,200.00
National treasurer, salary	300.00
National secretary, salary	2,400.00
National vice president, salary	300.00
National treasurer, office expenses	125.00
National trustees, expenses	300.00
National Engineer, propaganda	200.00
	$27,125.00

A resolution recommending that isolated plants and central stations be compelled to combine operations to save coal was tabled. Election of officers resulted as follows: Roderick Mackay, of Los Angeles, president; John J. Calahan, of Jersey City, vice president; F. W. Raven, of Chicago, secretary; Samuel B. Forse, of Pittsburgh, treasurer; Joseph F. Carney, of New York, trustee of *National Engineer* for five-year term; N. E. Parrish, of Louisville, conductor; Eugene Kissel, of Portland, Ore., doorkeeper.

Huntington, W. Va., was selected as the convention city for 1919. One of the incidents of the convention was the presentation to President Wickert by the National Exhibitors' Association of a $100 Liberty Bond as an appreciation of the coöperation he had given them. Installation of officers and the grand ball Friday evening at the Sinton Hotel were the closing features of a most successful convention.

As officers for the ensuing year the Ladies Auxiliary elected Louise Mullen, president; Anna C. Artkamper, vice president; Lenore W. Farmer, secretary; Mary T. Mahon, treasurer; Emily Hill, doorkeeper; Anna C. Morris, chaplain; Grace Rife, conductor.

Election by the National Exhibitors' Association resulted in the following choice of officers: Charles Cullen, of the William Powell Co., president; H. A. Smith, of the Philadelphia Grease Co., vice president; F. N. Chapman, of the Leschen & Sons Rope Co., treasurer; Thomas Green, secretary; L. W. Brooks, Frank Martin, W. L. Rogers, Hudson Dickerman and Horace Rand, executive committee. Considering war conditions, the exhibits were numerous and attractively arranged.

Win-the-War Meeting Held by Water-Works Men

Saving water and coal by preventing waste and by the better operation of pumping plants, the fuel situation in New England, water rates, labor problems and evidence of strong patriotic feeling throughout were features of the win-the-war meeting of the New England Water-Works Association held at Boston Sept. 11 and 12. The usual exhibits and various entertainment features were omitted. All things considered, the attendance was good. The total registration was 146. Of these, 94 were active, 32 were associate members and 20 were guests.

Close attention and enthusiastic applause were given by the audience to an address by Prof. William T. Sedgwick, Massachusetts Institute of Technology, and past president of the association, and chairman of the Massachusetts division of the National Security League. The address was entitled "From Peace to War, from War to Victory, from Victory to Judgment." It reviewed the causes of the war and the conduct of Germany before and during the conflict. The necessity for the punishment of Germany was urged, not in the spirit of revenge, but for the same reason as the criminal is punished anywhere and everywhere in civilized society; that is, for prevention.

The Fuel Problem in New England

No one subject was given more attention by the meeting than the fuel problem. The coal situation in New England was reviewed briefly by Ira M. Hollis, president of Worcester Polytechnic Institute. Suppression of industry and elimination of coal consumption is not coal conservation in his opinion, nor is using wood or finding any other substitute. Conservation rather is a matter of stopping waste. As an illustration of what can be done, President Hollis said that last December a certain contractor was using coal at the rate of 950,000 lb. a month. A local committee was appointed to study the subject and effect reductions, with the result that the March coal consumption was only 550,000 lb.—March and December being much alike. This is a shameful confession, President Hollis said, especially in view of the fact that last winter wounded soldiers in hospitals in Italy had no heat whatever. The question that should be constantly before us is, Are we doing all we can so our boys can come home?

In the opening part of a paper on the fuel situation. Charles T. Main, consulting engineer, Boston, stated that there would probably be a shortage of millions of tons of bituminous coal in New England this coming season. He

presented in detail measures that may be taken to meet this situation. An abstract of his paper will be published in a later issue.

After the severe cold spell last winter the association appointed a committee to investigate and report on the subject of frozen water pipes. The report of the committee was submitted by its chairman, Frank J. Gifford, superintendent of water-works Dedham, Mass. Mr. Gifford stated that the committee sent out 215 inquiries and received 95 replies. Very few superintendents ever experienced such extremely cold weather before.

In the discussion of the report Frank McInnes, of Boston, a member of the committee, said he was impressed with the need for all possible data as to how water pipes can be thawed by electricity without damage. He had found the use of a storage-battery apparatus very successful in Boston last winter, but this device proved to be dangerous unless properly operated. It is too delicate for general use. A paper on "Detecting Leaks in Underground Pipes" was presented by David A. Heffernan, superintendent of water-works, Milton. Several members spoke favorably of the use of water-leak locators.

"Quartermaster Terminals Required for War Work" was the subject of an address by Major Charles R. Gow, construction quartermaster, Boston. The construction of the Squantum destroyer plant was described by Thomas C. Atwood, resident supervising engineer. Major Gow remarked that with 5,000,000 men overseas it would be necessary to ship 125,000 tons a day of supplies. This would require one train of 40 cars every twelve minutes in the twenty-four hours or twenty-one 6000-ton cargo ships per day, and the continuous service of about 600 ships.

The Squantum destroyer plant, Mr. Atwood said, was covered in, both ways and wet basins, at an extra cost of $2,000,000 for roofing. This extra cost would be paid for if destroyer construction was speeded up sufficiently to save only one ship from destruction.

A Radical View of Meter Rates

In the course of a talk on the need of higher water rates to offset increasing cost, John J. Moore, consulting engineer, Boston, spoke strongly against supplying water in large quantities at a reduced rate. He said that if meter rates were to slide they should slide downward or with decreasing consumption, rather than downward with increasing consumption. The reason that he gave for this was that in the case of many works the large consumers make a heavy demand upon the supply which oftentimes entails an increase in the capacity of works at a larger expense. He favored a flat meter rate. Several speakers agreed with him.

Mr. Moore also urged the general proposition that where it is necessary to get more water revenue by increasing rates, the increase should be in the nature of hydrant rental instead of raising the rate for domestic and industrial uses. Private water companies, Mr. Moore said, are having to pay largely increased taxes compared with a few years ago. Their property is assessed at its full valuation, whereas other property in the same community is assessed at only a percentage of the value.

Water-Works Labor Troubles

Opening a discussion on this subject, C. E. Davis, chief of the Bureau of Water, Philadelphia, and president of the association, said that an effective pension system in Philadelphia had had a stabilizing effect on the employees. It has kept many of them from going into private employment even at much higher rates of pay. Mr. Bingham, city manager, Waltham, Mass., said that in his city, with a pension system in force, out of 100 employees 60 were working, 30 were cut on strike for more pay and 10 were on the fence. If the demand for higher wages were to be granted, it would add $7500 a year to the payroll. There was no money available to meet the increase. A speaker from Woburn said that the minimum wage had increased there in the last three years from $2 to $3 a day. The men got a raise to $3 by threatening to strike after the mayor had refused to grant the increase. Some of the men were disappointed because there was no strike. Later a demand for $3.50 a day was made, and the mayor was advised to grant the increase, but he refused and some of the men have already quit to work elsewhere for higher wages. The speaker urged that men in municipal employ should be regarded as on a different basis than those in private employ, since the former are really municipal stockholders. John M. Diven, superintendent water-works, Troy, N. Y., and secretary of the American Water-Works Association, said that most of the water-works are operated on the budget system, making it hard to increase wages on demand. In Troy a wage increase has been granted three times of late. This has been made possible by cutting down work and keeping the best men.

Fuel Regulations

In an address Sept. 10, before the annual convention of the National Association of Stationary Engineers, at Cincinnati, Ohio, P. B. Noyes, Director of Conservation of the United States Fuel Administration, said in part as follows:

It is estimated that the needs of the war call for at least one hundred million tons more coal this year than in 1917 and two hundred million tons in excess of that provided in 1914, the year the war started. As figures, this does not sound difficult, but when we consider that this increase must be produced by a lessened man power and a railway system very little improved since the war started and taxed with inconceivably large demands from every war-making department, and when we picture this increase of coal as being four-fifths as much as was excavated during the sixteen years of the building of the Panama Canal, you will realize that we have a problem out of range of any other.

These war needs must be met by the most intensive work in three directions: First, the increase of production; second, through conservation, through saving in every possible way; and third, by a distribution system which shall insure against "lost motion," which shall fit our cloth exactly to the pattern.

The Fuel Administration has been putting its most intensive work on increasing the production. This is evidenced by the fact that while every European country has decreased in coal production since the war began, the United States mined fifty million tons more coal during its first year of war and will increase that by another fifty million tons this year.

In almost any other line of activity the enterprise and energy of America is looked to to make good, no matter what the figures. Coal alone is of too huge bulk to be increased to any extent quickly. You must remember that 52 per cent. of all railway cars loaded with coal, a tonnage equal to the great cotton crop of the United States is moved every 1⅛ days; every eight days we are mining and transporting as great a weight of coal as the entire wheat crop of the United States. Our miners go deep into the earth and painfully bring up a tonnage of coal, and our railroads transport it an average of 300 miles every year, equivalent to 2¼ Panama Canals. We have fewer men in the coal mines than two years ago and will mine one hundred million tons more than then.

The Conservation Bureau has organized, as you know, power, light and fuel conservation, going into every industry in the United States in addition to intensive work on domestic consumption. The figures coming in already are very encouraging. We have set a quota of 35 million tons to be saved in the boiler and power houses of industry and 15 million tons in the homes. If this can be accomplished, the gap between our increased production and the much greater increase of demand will be filled.

Distribution is perhaps organized in the Fuel Administration more thoroughly than any other part of the work. Every week the Distribution Department lays on Mr. Garfield's desk a statement by districts, by states and as a nation, showing the amount of coal produced during the week before in all of the ten thousand or more mines, also a statement of the amount consumed taken from the postal-cards reports with which you are familiar, and lastly, a statement of the amount of coal on hand, adding together the stock piles of every industry and every dealer in the country. With this information, the streams of coal can be directed intelligently, shifted from time to time and made to do all the work permitted by the coal mined.

But in the present crisis of the war with success depending upon steel, and steel depending upon coal, no ingenuity, rules or efficient administration will save us with-

out practically 100 per cent. coöperation from the people of the country.

We sometimes complain that the business men give us only a part of the coöperation we should have, that their attention is still divided by personal interests. I have found, however, in a year's association with the business interests, that it is only necessary that men like yourselves should know what we know in Washington—should see the meaning of a shortage of coal for the war as I see it every day in my connection with the War Industries Board—to get a coöperation which will ask only that it be told what sacrifice will really help.

On Mar. 21 Germany taught the world a new military science—that an overpowering weight of munitions and shells, guns, tanks, airplanes, etc., will bring success with a minimum of casualties. Germany got together a supply of all these munitions beyond anything the world had ever seen before. The Allies have profited by this experience. Guns, shells and everything else contributing to the saving of lives are being forwarded to France in unbelievable quantities. The program is founded on demonstrated fact that if you have shells to waste lives can be saved. From now on it is munitions against casualties.

If you keep this in mind, you will have the background for the sternly drastic attitude of the Government during the next six months in clearing the way for filling Pershing's orders.

Gentlemen, we are facing a catastrophe. It is not one of those catastrophes which makes such a noise that everyone knows when it happens. It is a silent tragedy. We cannot fill Pershing's orders in full because the United States cannot make sufficient steel this winter. A shortage in steel results almost entirely from lack of coal. Keep this in mind and then look forward to the events of the coming spring. We shall have the drive. We shall succeed in it, but some time in February or March, or whenever the time has come, General Pershing will sit down with a pencil in hand, will figure up the exact deficit in the filling of his order for munitions. With military formulas now well recognized he will figure in place of those munitions how many extra men must be put into the battle to be killed. This is no fanciful statement. It is now possible to treat, in any aggressive movement, the question of munitions or of casualties as interchangeable quantities. So many thousand American youths must be thrown into the hopper for every thousand tons of munitions which are short.

With this background I know that discussion with any men present of wastage of coal or of coal to be used for any industrial or economic consideration would be very one-sided. You will go just as far as any of us in Washington in urging that no consideration be given to any economic compromise with the coal supply which balances civil prosperity against men's lives.

This statement of the case sounds tragic, but the worst of it is that it is terribly true, so true that I feel confident if every American business could see the actual facts as they come to us in Washington, there would be no need of regulations or rules, only directions. No man here would spare himself either labor to save the last pound of waste or the sacrifice involved in devoting the fuel and material he needs most to helping to complete the Pershing program.

Ohio State Convention

The Ohio State Association of the N.A.S.E. held its annual convention in Cincinnati on Sept. 8 and 9, just previous to the national convention. The meeting opened on Sunday morning, Sept. 8, John Fehrenbach, chairman of the local committee, presiding. Judge S. W. Bell welcomed the delegates and visitors to the city and made a stirring patriotic address.

State President Kroner, who was then introduced, laid particular stress on the loyalty of engineers at the present time, the fundamental principles of the organization being loyalty and education. National President John Wickert emphasized the two salient features of the organization introduced by Mr. Kroner. A large number of members of the N.A.S.E were in service, and there were no slackers. The causes for lack of interest at meetings and nonattendance were also discussed by the speaker.

Past-President John Kerley made a spirited appeal for loyalty to both the National Government and to the N.A.S.E. He believed that the future held bright prospects for the members of this order. In his opinion discussions of various subjects in open meetings was of great educational value.

William Reynolds, national trustee, made a number of suggestions regarding the enlistment of new members and of maintaining interest in association affairs. He criticised the attitude of some examining committees as tending to alienate the new member more than to gain his good will. In his opinion the only requirement for admission should be the requisite amount of experience as required by the constitution. After this it was up to the member himself and to the association to help him along in his efforts.

Roderick Mackay, the incoming national president, referred to the conditions existing due to the war and how little the average American had been touched by it so far, as compared to European countries. At the conclusion of the addresses Chairman Fehrenbach turned the meeting over to State President Kroner, who appointed the usual committees.

At the afternoon session reports were made by the officers of the state association. The president referred briefly to the work that had been done to obtain a more satisfactory license law. He also urged the delegates to secure greater attendance at their local meetings. The secretary's report showed the state association in good financial condition. The membership of the association was 1763.

The license committee advised against any further license legislation at the present time, but recommended that the remuneration of the state examiners be increased and that there should be twelve districts instead of the ten at the present time. In some of the districts there was entirely too much for one man to do. Increase in salaries was imperative if an efficient inspection force was to be maintained. This was followed by a discussion on increasing attendance and maintaining interest in the meetings by National Vice President Mackay, Judson Pratt, Mr. Fischer and others.

At the Monday morning session the report of the Credential Committee showed 22 delegates present and registered. At the afternoon session the following officers were elected: President, Louis Kroner; vice president, John A. Matz; secretary, Mr. Kennedy; treasurer, Mr. Garrett; doorkeeper, F. B. Seidel; conductor, Linus Wolf; recommendation for state deputy, Robert Patterson.

The selection of a convention city was left to the incoming officers. A recess from business was then declared, and Royal H. Holbrook, state deputy of Iowa, and a member of the Fuel Administration of that state, addressed the convention. He discussed the development of furnace and boiler construction, calling attention to the gradual increase in the distance between the grates and the boiler and the great advantage of this feature. Particular stress was laid on the fact that in the organization of the Fuel Administration in Iowa all were members of the N.A.S.E. The present agitation had brought the association prominently to the front and he expected a brilliant future for it in his state. He was of the opinion that throughout the country a good deal of aggressive work would be required of the officers, but taking everything into consideration the prospects were good for the future.

The method employed by the Fuel Administration in Iowa was first to bring the man who pays for the coal in contact with the man who burns it. The next move was to call attention to uncovered pipes, leaks at the blowoff valves and in the piping, soot on the heating surface and air leaks in the setting.

The next in order was the appointment of a legislation committee by the president and the installation of the newly elected officers. The convention then adjourned to meet again on June 3, 1919, at a place to be chosen later by the officers of the state association.

A Pittsburgh special to the *New York World* says there are approximately 3200 industrial plants operating in the Pittsburgh district. Of these, about 2000 are performing war work. The number of men employed is not far from 250,000, three-fifths, or 150,000, of whom are actively engaged in producing war material. The payroll in the Pittsburgh district totals something like $2,000,000 a day, and the approximate value of the war contracts is in excess of $2,500,000,000.

Railway Engineers Meet at Chicago

On Sept. 9 at the Fort Dearborn Hotel, Chicago, engineers in charge of railway stationary power plants held a one-day meeting at the instigation of Eugene McAuliffe, manager of the fuel conservation section of the United States Railroad Administration. Questionnaires already had been sent out, but the meeting had been called to direct attention to the unusually inefficient conditions existing in the average small railway plant, to create enthusiasm and get everyone working on the all important problem of saving coal. This was to be done, not by installing new equipment, but by applying common sense to operating methods and to improving existing conditions. In this connection numerous valuable suggestions were offered at the convention.

In his opening remarks Mr. McAuliffe, chairman of the meeting, made plain the necessity of saving coal. The average railway plant had been very wasteful and it was important that as much attention be given them as locomotives had received in the past.

Of the various representatives of the Fuel Administration present, David Moffat Myers, from Washington, was the first to speak. By eliminating needless waste in industrial and railway stationary plants a 10 per cent. saving, amounting to 50,000,000 tons of coal per year, was readily possible. The speaker told how the Fuel Administration had been formed and extended to include administrative engineers for each state. The questionnaire plan for improving economy was not a product of the Fuel Administration. It had been formulated at various conferences by representative engineers throughout the country. It was not perfect, there was room for improvement and the administration was open to suggestions. A good organization existed and was at the service of the railway plants.

George Henderson, administrative engineer for eastern Pennsylvania, gave an instructive talk on what had been done and the results obtained in his state. He emphasized the importance of weighing coal, measuring water and keeping the plant in good operating condition. Use of exhaust steam had been neglected by the railways and there was lack of proper supervision, the most important factor of all. By doing the best that was possible in an old plant a better rating might be obtained than with a new plant. Small savings were just as important as large ones, if the same percentage of consumption was saved. In fact it was in the small plant that the opportunities for saving were greatest. In the consolidation of plants there were great possibilities.

Joseph Harrington, administrative engineer for Illinois, expressed satisfaction at the coöperation he was meeting throughout the state. There were two broad divisions, one the physical and the other the human side of the equation. It was merely a question of how much engineers were going to apply of what they knew about obtaining efficiency. In the small pumping stations of the railways, a saving of one or two tons of coal per month possibly did not seem worth while, but when this small saving was multiplied by the number of the plants, running into the thousands, the aggregate saving was a big item. Mr. Harrington did not advocate buying new equipment as present conditions would not permit of its delivery. There were a few fundamentals, such as pipe covering, soot cleaners, preparations for making the settings tight, that could be obtained and were necessary for efficient operation.

Too many instruments were worse than not enough. In the opinion of Mr. Harrington a two-pen recording draft gage was the best instrument for keeping in touch with combustion efficiency. The continuous records also had a psychological effect on the fireman. The instrument mentioned, coupled with weighing the coal, and a good inspector operating in a district small enough so that he could give his personal attention to each plant, gave the fundamentals for an improvement in efficiency.

Osborn Monnett, now assistant to David Moffat Myers at Washington, referred to his previous experience in a railway power plant. The railways formerly viewed the coal for stationary plants from the financial standpoint. Today coal must be saved because it is scarce. The speaker enumerated a few simple things that could be done to save coal. The grates must be properly proportioned to the heating surface, attention should be given to the rate of combustion and it is important to have proper gas areas throughout the boiler. The heating surfaces should be kept clean and the coal should be weighed or measured in some way. Where there is nothing better available, a simple method is to build an open form having a capacity of ten cubic feet. This is placed on the floor, filled with coal, and pulled up to release the coal for firing. To determine the weight of coal fired it is merely a question of keeping track of the number of times the form is filled during a shift. By adopting efficient operating methods it will be possible, in many a small plant, to save as high as 25 to 30 per cent. of the fuel.

N. G. Phelps, representing the oil division of the Fuel Administration, discussed fuel oil for industrial purposes and for steam generation. What had been said about coal also applied to oil. It was a simple matter to operate an oil-burning plant and for that very reason the efficient burning of oil had been neglected. Rather than to decrease the supply to the consumer, the Fuel Administration at first tried to increase the production. The increased demand, however, now made it necessary to go to the consumer. The country was facing a shortage of 29,000,000 bbl. of oil and it was estimated that a billion gallons were being wasted annually. Much of this waste was due to improper combustion. In industrial furnaces there was no way to satisfactorily make CO_2 analyses. Observation of the fire was about the only way to determine the efficiency of combustion. A light-brown appearance indicated good combustion. It is important to use the proper design of burner. If the burner is not adapted for the pressures of the air and oil, maximum efficiency cannot be obtained. The speaker objected to the use of home-made burners as in most cases they were not properly proportioned. To secure the highest efficiency the air and oil pressures should be equalized and the oil should be preheated to at least 110 deg. F. There should be proper storage tanks and no leaks in the supply line. Complete records of oil consumption and other operating data were important and this applied to industrial furnaces as well as the boiler plant.

At the afternoon session John Anderson, chief engineer of power plants of the Milwaukee Electric Railway and Light Co., gave a very interesting account of the powdered-coal installation at the Oneida Street Station of the company. One 500-hp. water-tube boiler had been equipped to burn powdered coal, and after some initial difficulties had been overcome, remarkable results were obtained. The speaker was very enthusiastic over the prospects. They now had a standard installation and it was the intention to equip five boilers. Higher maintained efficiencies were possible with powdered coal, the tubes remained clean, and the operation was extremely simple. Complete details of Mr. Anderson's talk will be given in an early issue.

Following, numerous speakers brought out the various defects existing in the small railway plant. The money value of these leaks was indicated and the railways in general were accused of neglect. The engineers in the plant in most cases knew how savings could be effected, but they had not been impressed with the fact that coal was valuable. In the small plant the engineer did not know anything about CO_2, but he could stop up leaks and do the self-evident common-sense things that would improve the economy. The main thing was to arouse enthusiasm, get the fireman interested and make somebody responsible for the stationary plants. Send him from station to station to put the plants in shape and instruct the firemen and insist upon return visits to see that his instructions had been complied with. The fireman must be impressed with the fact that the duration of the war depends directly upon his efforts. Even the saving in one small plant may be the "straw" that will decide whether the war is to last one or several years. There was a wonderful field for saving in the railway stationary plant, and judging by the enthusiasm displayed at the meeting, the representatives of the various railways were determined that a remarkable showing would be made in their plants the coming year.

Large Saving of Coal in Power Plants

Before the war power produced uneconomically was merely a question of expense, but now it is playing a large part in the coal-saving program of the Fuel Administration. The Power Section of the U. S. Fuel Administration has made a survey of generating plants throughout the United States and its agents have been arranging for many changes in the direction of economy.

Figures are now coming in showing substantial savings of coal from the power changes already made. Consolidation of power plants at Richmond, Va.; Ludlow, Mass.; Wooster, Ohio; Charleston, W. Va.; Kirkwood, Mo., and at Clinton, Ind., reported to the Fuel Administration, will mean a yearly saving of 35,000 tons of coal. In these locations the most economical stations have taken over the less economical ones. In several places two or more utilities were rendering similar service.

The Mammoth Springs (Mo.) Light and Power Co. has effected new power contracts whereby excess water power is replacing power generated from coal. The saving will approximate 2000 tons of coal annually. In Keokuk, Iowa, the application of water power for power needs has replaced the supply formerly produced by steam in St. Louis, Mo. The saving here is about 110,000 tons each year.

Power from more efficient stations has been substituted and 8 private electric generating plants have closed down in Missouri, 40 in New York City and 25 plants in Chicago. These instances are typical of what is being done throughout the country by the interconnection or substitution of one kind of power for another to effect fuel savings.

Fxhibit of Foreign Electrical Goods at New York

At the district office of the Bureau of Foreign and Domestic Commerce, in room 734, of the New York Custom House, there is now on display a large collection of samples of electrical goods used in foreign countries. The exhibit includes wiring devices, heating appliances, electrical porcelains, dry cells, flash lights, electric bells, conduit and conduit fittings, insulated wire, etc.

These samples have been forwarded mainly in connection with the special investigations undertaken in South America, Australia, New Zealand, China, Japan and Eastern Siberia by special agents of the Bureau. Complete data accompany each article on exhibit, giving country of origin, where obtained, how used, selling price, etc.

There are several hundred articles in the exhibit, and these have been specially arranged for inspection by electrical manufacturers and exporters in order that they may make a personal study of the classes of goods with which their products come into competition abroad, and learn the electrical practices in the different countries from which the samples have been secured.—*Commerce Reports.*

Army Water Supply

To a large extent water for the Allied forces on the Continent is obtained from wells. The British territory is underlaid with chalk, and it is necessary to sink driven wells from 150 to 250 ft. to reach the level of saturation. With two shifts the drilling progress on a 6-in. hole varies from 20 to 60 ft. a day, and the yield per well may range from 50 to 150 gal. per min. In the Somme valley British troops used river water, which was passed through purification plants mounted on barges. About four-fifths of the French army water supply in the region of Verdun was obtained from wells. Wells dug by hand, in addition to drilled wells, are also employed to some extent—one of them was put down to a depth of 65 ft. If time permits, these dug wells are lined for the upper 10 or 12 ft., and a curb 2 ft. high is built around the top to prevent *débris* or waste water falling back into the well. For dug wells a round section about 4 ft. in diameter is common.—*The Engineer*, London.

Price Allowances on Emergency Deliveries

Railroad companies delivering coal to consumers by order of the United States Fuel Administration for the purpose of relieving emergencies will be allowed to add to the cost of such coal an amount to cover extra switching, handling and accounting. An order to that effect issued by the Fuel Administration became effective Sept. 5.

The order provides that the railroad may receive from the consumer or retail dealer to whom coal is so delivered the cost of the coal including lawful transportation charges from point of origin to destination, and the additional sum of 15c. per net ton, or such greater additional sum as may be agreed upon by the railroad company and the consumer or dealer. In case of failure to agree on a settlement beyond the allowances specified, the Bureau of Prices of the Fuel Administration will determine and adjudicate such differences as may occur.

Stoker Manufacturers Organize

A national organization, known as the Stoker Manufacturers' Association, was voluntarily formed by all automatic mechanical-stoker manufacturers, primarily to so improve the engineering and business sides of the stoker industry as to render it more efficient and better equipped to utilize coal more economically and to better serve the Government during the war. The movement is in no sense a business combination.

Under war conditions capacity and economy are the big factors in stoker operation. Improvements are to be expected as a result of technical discussion and interchange of ideas at annual conventions to be held by the association. The organization will also insist upon uniformity of guarantees which will relate only to the stoker and not, as hitherto, include the performance of the boiler and draft-producing apparatus. The War Industries Board was quick to accept the offer of assistance made by the association, asking only that each manufacturer make an individual monthly private report of conditions of the trade direct to the Government in order that each might secure proper priorities to facilitate deliveries to essential industries.

The executive committee of the association includes: President, P. A. Poppenhusen, Green Engineering Co., Chicago; vice president, S. L. Nicholson, Westinghouse Electric & Manufacturing Co., East Pittsburgh; secretary-treasurer, F. H. Daniels, Sanford Riley Stoker Co., Ltd., Worcester; W. F. Sauter, American Engineering Co., Philadelphia; W. H. Rea, Detroit Stoker Co., Detroit.

United States Fuel Administration to Hold Great Win-the-War Meeting

Under the auspices of the United States Fuel Administration, Division of Coal and Oil, Washington, D. C., headed by Dr. H. A. Garfield, Federal Fuel Administrator, and M. L. Requa, Director of Coal and Oil Division, coöperating with the engineering societies of New York and all stationary and marine firemen, a great patriotic meeting will be held at Cooper Union Institute, New York City, on Sept. 28. David Moffat Myers, advisory engineer to the United States Fuel Administration, and prominent officials of the administration, as well as representatives of many engineering associations, will address the meeting. It is the patriotic duty of every engineer, fireman and user of coal to respond to this call, and they are urged to attend the meeting.

Increased Power Planned

The Consolidated Gas, Electric Light & Power Co., Baltimore, Md., is installing two new steam-turbine units which, when completed, will give an additional capacity of 40,000 kw. When the installation of these units is completed no immediate power shortage is anticipated. It is understood that the company is about to order equipment for as much more power as is now being installed.

New Publications

A CONVENIENT MULTIPLE-UNIT CALORIMETER INSTALLATION. By J. D. Davis and E. L. Wallace. Technical Paper 91, Department of the Interior, Bureau of Mines.

This publication deals at length with the details of construction and arrangement of the multiple-unit calorimeter installation used by the Bureau of Mines. It is necessary to make from 90 to 150 calorimetric determinations per day, and this necessitated the use of a battery of calorimeters arranged so as to be handled rapidly yet without loss of accuracy. The pamphlet describes the form of bomb used, the method of gold-plating it to make it acid-resisting, the construction of the calorimeter can, the arrangement and method of driving the stirrer, the control of temperature of the bath, the handling and measurement of water for the calorimeters, the devices for measuring temperatures, the calibration of instruments used, the determination of the water value of the calorimeter, and the accuracy attainable with the calorimeters. While it is probable that few other laboratories require so large a calorimeter outfit as that used by the Bureau of Mines, the information contained in this publication cannot fail to be of interest and value to anyone engaged in fuel calorimetry.

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA. By A. L. Dyke. Published by A. L. Dyke, St. Louis, Mo. Cloth; 6½ x 9½ in.; 932 pages; 3400 illustrations. Price, $3.50.

This is the eighth edition of this book, considerably enlarged over the preceding edition. It covers the entire field of the gasoline engine as applied to automobiles, motorcycles, trucks, airplanes, tractors and marine service; but the greater part of the book is devoted to automobiles and their accessories. The sections dealing with tractors, airplanes and marine engines are exceedingly brief and contain nothing that is not given to better advantage in other publications. In the field of the automobile, however, the scope of the book is very wide. It describes the construction of cars, and their parts, explains their methods of operation, tells how to adjust and repair them, touches on touring and salesmanship, and in general lives up to its title of being an encyclopedia. Most of the illustrations appear to be catalog cuts and reproductions from magazines, and the arrangement of the material gives many of the pages the appearance of a catalog. Nevertheless, the book contains a large amount of information, gathered from every available source, and it will doubtless appeal to those who wish to obtain the facts without being concerned as to their form or manner of presentation.

Obituary

Prof. William Kent, of Montclair, N. J., eminent engineer and author of many technical books, died on Sept. 18 at Gananoque, Ont., in his sixty-eighth year. A fuller obituary will be published in next week's issue.

Personals

F. W. Vormelker has been appointed efficiency engineer of the Russel Motor Axle Co., North Detroit, Mich.

Henry Misostow, formerly with the smoke department in Chicago, has accepted a position as mechanical engineer for the Indiana Steel and Wire Co., of Muncie, Ind.

LeRoy Gordon, well known in the valve and steam specialty trade, has been appointed Eastern representative for the M. B. Skinner Co., of Chicago, with headquarters at 51 E. 42nd St., New York City.

Walter G. Diman, who is superintendent of power with the Amoskeag Corporation at Lawrence, Mass., has been appointed chairman of the New Hampshire conservation division of the United States Fuel Administration. He will have charge of all problems such as blocks, institutions and apartment houses that have been burning anthracite and that will have to burn bituminous in the future.

Charles M. Rogers, who for several years has been engineer for the Southern properties of Henry L. Doherty & Co., has accepted an appointment for the duration of the war as engineer for the Gulf Coast Division, Bureau of Oil Conservation, Oil Division of the United States Fuel Administration, with headquarters in New Orleans, La.

Engineering Affairs

The American Institute of Electrical Engineers will hold a joint meeting with the Physical Society in Philadelphia, Oct. 11-12.

The College of Engineering of the University of Illinois announces the following new appointments: Edgar McNaughton as associate in mechanical engineering. He has had full charge of the course in machine design and of the steam and gas laboratory for the past two years. Earl D. Hay as associate in machine design. He has been professor of drawing at the Oshkosh (Wis.) Normal School for the last five years. Hussein H. Fikret as instructor in mechanical engineering. He was construction engineer in mechanical and electrical laboratory installations for Dean John R. Allen at Constantinople, Turkey and more recently instructor in aero engines in the United States Army school of military aëronautics at the Ohio State University. Francis A. Hobart as instructor in machine-shop practice and management. He was until recently instructor of machine-shop practice at the University of Minnesota.

Miscellaneous News

A Large Boiler Exploded at the works of the Ralston Steel Car Co., East Columbus, Ohio, on Sept. 2, instantly killing two persons who were working near-by.

The Boiler of a Threshing Machine Exploded on Aug. 31, on the farm of Earl Marken, 3½ miles northeast of Hansell, Iowa, seriously injuring one person and killing a team of horses.

A Boiler Exploded aboard a derrick boat at Fox Island, 45 miles below Memphis, Tenn., on the Mississippi River, Sept. 4, instantly killing four persons and seriously injuring four others, one of whom died later at a hospital. After the explosion the derrick, blown almost in two, sank in twelve feet of water.

A Boiler Exploded on a threshing outfit while it was being moved along the main road to a neighboring farm, about three miles east of Prairie Du Chien, Wis., on Sept. 4, instantly killing the owner and injuring two others, and completely wrecking the outfit. Low water is given as the cause of the explosion.

A Locomotive Boiler Exploded on a New York Central train on Sept. 12, near Castleton, N. Y., seriously injuring the engineer and fireman, the former probably fatally. The train was going at a high speed when the explosion occurred. Both men were blown out of the cab and were picked up about thirty feet away. It is thought that the brakes were thrown on by the explosion.

A Freight Engine Boiler Exploded on the Lehigh Valley R.R., near Corfu, N. Y., on Sept. 5, instantly killing three men, the engineer, fireman and brakeman. The engine was the first of a double header drawing an eastbound train. The explosion lifted the boiler, cab and all the upper works of the engine clear of the trucks and turned them top downward on the westbound tracks clear of the second engine.

Making Study of Gasoline Costs and Prices. Concerning the report that the Fuel Administration is contemplating the fixing of the price of gasoline throughout the country, Mr. Garfield stated that a study is being made of costs and prices and that on the basis of this investigation it is expected shortly to effect such a readjustment of prices as may be found to be reasonable and necessary.

The U. S. Navy Gas Engine School, of which Lieut. Commander Charles E. Lucke is director at Columbia University, New York City, is desirous of obtaining the names and addresses of men who are willing to enroll for training for the position of chief engineer, warrant machinists and chief machinist mates on board the new submarines of the U. S. Navy. Such applicants must be men who have had extended experience in the operation of Diesel or other heavy-oil engines. They must be fully capable of taking charge of Diesel engines and making ordinary repairs and be competent to foresee trouble and maintain the engines in efficient operation. Only those possessing such qualifications can be considered. Such applicants should be between the ages of 21 and 35, but the applications of men up to 40, if exceptionally well qualified, will be considered. The rates of pay are most attractive and the several months training which applicants accepted for this work will undergo, is most advantageous and will fit them for positions of larger responsibility than most of them now are capable of. Anyone possessing the qualifications cited and desiring to serve in this most important work should send name and address in to Lieut. Commander Lucke at the address given.

New Construction

Proposed Work

Mass., Brockton—The Geo. E. Keith Co., 1224 Main St., plans to build a 64 x 71 ft. central heating and power plant, with a capacity for 300 hp. boilers.

Conn., Hazardville—The Gordon Bros., Scitico St., Thompsonville, has awarded the contract for the erection of a 2½ story, 22 x 52 ft. power house, to the Ellison Const. Co., 60 Prospect St., boilers and electrical power will be installed in same. Total estimated cost, $30,000.

Mass., Marlboro—The Koehler Manufacturing Co., Howland St., is receiving bids for the erection of a 1-story, 40 x 80 ft. power house. Estimated cost, $20,000.

Mass., South Worcester—The New York, New Haven and Hartford R. R. has awarded the contract for the erection of a boiler house, generating room, engine house, etc., to F. T. Ley and Co., Springfield. Equipment including boilers will be installed in same. Estimated cost, $55,000.

Mass., Springfield—The Hendee Manufacturing Co., 837 State St., has awarded the contract for the erection of a boiler and hardening room, to E. J. Pinney, 264 Main St., New B. & W. Boilers and electrical power will be installed in same. Total estimated cost, $37,000.

Conn., Bridgeport—The New York, New Haven and Hartford R. R. Co., Meadow St., New Haven, is receiving bids for the erection of a 1-story engine house. Estimated cost, $75,000. E. Gagle, Ch. Engr.

Conn., Hartford—Greenwood & Noerr, Engr., 847 Main St., is receiving bids for the erection of a 1-story, 50 x 106 ft. machine shop for the Ainslie Machine Tool Co., Jefferson Ave.; equipment including motors, belting, etc., will be installed in same. Total estimated cost, $18,000.

Conn., Waterbury—Hugh L. Thompson, Engr., 57 North Main St., will soon receive bids for the erection of 2-story, 60 x 95 ft. pumping station for the Scoville Manufacturing Co., 99 Mill St., pumping machinery will be installed in same.

N. Y., Albany—W. W. Wotherspoon, Superintendent of Public Works, will receive bids until Oct. 9, for construction, heating and plumbing in connection with the proposed terminal freight shed at Pier No. 1, Erie Basin, Buffalo, Contract No. 212, 212H and 212P.

N. Y., Binghamton—The Binghamton Bridge Co., Press Bldg., has purchased a site and plans to build a hydro-electric plant here.

N. Y., Buffalo—The Curtis Aeroplane Co., 1972 Elmwood Ave., has awarded the contract for the erection of a 1-story, 50 x 100 ft. factory to the Austin Co., 16112 Euclid Ave., Cleveland, Ohio. A steam heating system will be installed in same. Total estimated cost, $25,000.

N. Y., Brooklyn—The Columbia Machine and Malleable Co., 269 Chestnut St., has awarded the contract for the erection of a 1-story, 80 x 160 ft. factory to the Austin Co., 16112 Euclid Ave., Cleveland, Ohio. A steam heating system will be installed in same. Total estimated cost, $50,000.

N. Y., Long Island City—The John Simmons Co., 110 Centre St., New York City, has awarded the contract for the erection of a 1-story, 80 x 200 ft. factory, to the Austin Co., 16112 Euclid Ave., Cleveland, Ohio. A steam heating system will be installed in same. Total estimated cost, $29,600.

N. Y., Syracuse—The Semet-Solvay Co., Milton Ave., has awarded the contract for the erection of a 1-story, 100 x 200 ft. castings factory to the Austin Co., 16112 Euclid Ave., Cleveland, Ohio. A steam heating system will be installed in same. Total estimated cost, $70,000.

Penn., Marcus Hook—The National Anilene Chemical Co. has awarded the contract for the erection of a 1-story, 106 x 196 ft. factory, to the Austin Co., 16112 Euclid Ave., Cleveland, Ohio. A steam heating system will be installed in same. Total estimated cost, $140,000.

Penn., Milton—The American Car and Foundry Co. has awarded the contract for the erection of a 1-story, 83 x 100 ft. factory to the Austin Co., 16112 Euclid Ave., Cleveland, Ohio. A steam heating system will be installed in same. Total estimated cost, $25,000.

Penn., Pittsburgh—The American Locomotive Co., 30 Church St., New York City, has awarded the contract for the erection of a 1-story, 50 x 122 ft. locomotive shop to the Austin Co., 16112 Euclid Ave., Cleveland, Ohio. A steam heating system will be installed in same. Total estimated cost, $52,000.

Ohio, Akron—Commissioners of Summit Co. will soon award the contract for the installation of a heating system in the Summit County Childrens' Home. L. M. Kauffman, Clerk.

Ohio, Barberton—City plans to build a west side sewer system; plans include the installation of pumps in the proposed 14 x 24 ft. brick and concrete pumping station. Total estimated cost, $85,000.

Ohio, Cambridge—The National Coal Co., 1503 Rockefeller Bldg., Cleveland, will install a steam heating system in the proposed 1-story, 150 x 250 ft. machine shop. Total estimated cost, $70,000.

Ohio, Cleveland—The American Steel and Wire Co., Western Reserve Bldg., will build a 1-story, 52 x 64 ft. power room on East 91st St. A steam heating system will be installed in same. Estimated cost, $20,000.

Ohio, Cleveland—The Board of Education, Rockwell and East 6th St., will install a steam heating system in the proposed 2-story school on Lucknow and East 149th St. Total estimated cost, $100,000. W. R. McCormack, Arch.

Ohio, Cleveland—The Craig Tractor Co. has awarded the contract for the erection of a 1-story, 60 x 180 ft. tractor factory, to the Austin Co., 16112 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $40,000.

Ohio, Cleveland—Fishel and Marks, East 55th St., has awarded the contract for the erection of a 1-story, 80 x 160 ft. structural steel factory on Krakow Ave., to the Pleas Construction Co., 6 North Clark St., Chicago, Ill. A steam heating system will be installed in same. Total estimated cost, $75,000.

Ohio, Cleveland—The Jordan Motor Car Co., 105 East 152 St., will install a steam heating system in the proposed 1-story, 100 x 250 ft. auto factory. Borchard Robert Wales Co., Swetland Bldg., Engrs.

Ohio, Cleveland—H. M. Morse Co., Engrs., 413 Citizens Bank Bldg., is receiving bids for the installation of a steam heating system in the proposed 1-story, 60 x 128 ft. factory for the L & N Co., 413 Citizens Bank Bldg. Total estimated cost, $50,000.

Ill., Madison—The Barber Asphalt Co. has awarded the contract for the erection of a 1-story, 100 x 180 ft. factory to the Austin Co., 16112 Euclid Ave., Cleveland, Ohio. A steam heating system will be installed in same. Total estimated cost, $35,000.

Wis., Kenosha—Jno. D. Chubb, Arch., 109 North Dearborn St., Chicago, Ill., will receive bids for the installation of a low pressure steam heating system in the proposed 2-story, 143 x 182 ft. grade school for the Board of Education. Total estimated cost, $275,000.

Wis., Rhinelander — The Rhinelander Paper Co., plans to build a 50 x 75 ft. boiler house. Estimated cost, $25,000.

Wis., Tomahawk—The Tomahawk Light, Telephone and Improvement Co. plans to extend and improve its power plant on the Tomahawk River. Estimated cost, $15,000. C. E. Extrom, Ch. Engr.

Iowa, Missouri City—J. F. Clinkenbeard, City Clerk, will receive bids for (a) installation of pumps to be used in sinking two, 12 in. wells or (b) installing three pumps in existing 35 ft. well and pump from reservoir to distributing reservoir or (c) sinking wells as in (a) and installing pump direct from wells to distributing reservoir—260 ft. lift, including two, 60 cycle, 3 phase, 2200 volt motors. Bids desired on both centrifugal and displacement pumps. C. L. Huff, Logan, Engr.

N. D., Fargo—The State is having preliminary plans prepared by Rose & Harris, Engr., 471 Auditorium Bldg., for the erection of a power plant at the University of North Dakato.

Utah, Ogden—Weber College is having plans prepared by Woods & Jensen, First National Bank Bldg., Arch. for the installation of a heating system here. Estimated cost, $10,000. J. Watson, Chmn.

Que., Cap De La Madeleine—The St. Maurice Paper Co., will install a heating system. Estimated cost, $12,000. J. W. Winton, Mgr.

Ont., Campbellford—The Provincial Hydro-Electric Power Commission, plans to build a power house at Ranneys Falls, to produce from 8000 to 10,000 hp. Total estimated cost,. $1,250,000.

Ont., Chatham—The Ursuline Cottage is having plans prepared by Amerman & McCall, Engr., 2348 Penobscot Bldg., Detroit, Mich., for the erection of a 1-story, 35 x 35 and 20 x 35 ft. boiler plant and coal room; equipment including boilers will be installed in same. Total estimated cost, $16,000.

CONTRACTS AWARDED

N. H., Ashland—The Ashland Woolen Co., has awarded the contract for the erection of a 1-story, 50 x 50 ft. power house, to C. W. Kieth, 2 Paxton St., Nashua.

R. I., North Smithfield—The Andrews Mill Co., Branch Village, has awarded the contract for the erection of a 24 x 36 ft. power house, 40 x 56 ft. boiler house, 80 x 47 ft. storehouse etc., to the C. I. Bigney Constr. Co., 898 Westminster St., Providence. Ttotal estimated cost, $265,000.

R. I., Woonsocket—The Star Carbonizing Co., has awarded the contract for the erection of a 24 x 34 ft. boiler room and a 53 x 175 ft. factory on Diamond Hill Road, to Wilfred Aubin, 1103 Diamond Hill Road. Total estimated cost, $50,000.

Conn., Bridgeport—The Locomobile Company of America, 2 Main St., has awarded the contract for the erection of two 1-story factory buildings and 2 1-story, 35 x 48 ft. boiler house, to the T. J. Pardy Construction Co., 15 Fairfield Ave. Estimated cost, $225,000.

N. Y., Albany—State Commission on New Prisons, Hall of Records, New York City, received low bids on work at Sing Sing Prison, Ossining, New York, as follows:

Edw. Joy Co., 125 Market St., Syracuse, heating work in Detention Building No. 5, $47,000. Underground heating work, $194,000; T. Frederick Jackson, Inc., 99 John St., New York City, $6,400; Jondous Electric Equipment Co., 109 West 31st St., New York City, $6730; Wheeler Green Electric Co., 29 St. Paul St., Rochester, $6,840; for electric work in Detention Building No. 5. Devoe Electric Co., 1 Green Building, Troy, $14,922. T. Frederick Jackson, 99 John St., New York City, $15,500; Mack and Mack, 103 Park Ave., New York City, $16,830, for underground electric work.

N. Y., Dunkirk—The American Locomotive Co., North Jay St., Schenectady, has awarded the contract for the erection of an addition to its boiler works here, to the Lackawanna Bridge Co., Bell and Abby St., Buffalo. Estimated cost, $150,000.

D. C., Wash.—Bids were received by the Bureau of Supplies and Accounts, Navy Dept., for furnishing equipment as follows:

Motor, Schedule 5633½, Class 350, delivery Philadelphia, Pa., from Ideal Electric and Manufacturing Co., 53 East 5th St., Mansfield, Ohio, $277; Lincoln Electric Co., Woodward Bldg., $396; Mechanical Appliance Co., 133 Stewart St., Milwaukee, Wis., $418; North Western Machine Co., 480 Clinton St., Milwaukee, Wis., $389; Alliance Electric and Engineering Co., Wash., D. C., $260; Robbins and Meyers Co., Lagonda and Farlow St., Springfield, Ohio, $446; Triumph Electric Co., South St., Cincinnati, Ohio, $462; Westinghouse Electric and Manufacturing Co., Hibbs Bldg., Wash., D. C., $361; American Sewer Pipe Co., 15 Broad St., Akron, Ohio, $375; Bell Electric Motor Co., Garwood, N. J., $371.

Motors, Schedule 5477½, Class 322, delivery Cape May, N. J., from Century Electric Co., 19th and Pine St., St. Louis, Mo., $107; Wm. Davis Machine Tool Co., 945 Pennsylvania Ave., N. W., Wash., D. C., $138; Kemp Machinery Co., 223 North Calvert St., Baltimore, Md., $118; Monarch Machinery Co., Chicago, Ill., $104; Manning, Maxwell and Moore, 119 West 40th St., New York City, $154; alternate, 143; Mechanical Appliance Co., 133 Stewart St., Milwaukee, Wis., $117; D. Nast Machine Co., Bourse Bldg., Philadelphia, Penn., $118; The Peerless Electric Co., West Market St., $97; Van Dyke Churchill Co., Philadelphia, Penn., $129; Wagner Electric Co., 6400 Plymouth St., St. Louis, Mo., $105; Erner Electric Co., 122 St. Clair Ave. N. E., Cleveland, Ohio, $94.

Motor generator set, Schedule 5763½, Class 586, delivery San Diego, Cal., from Ideal Electric Co., 43 East 5th St., Mansfield, Ohio, $1825; Northwestern Machine Co., 480 Clinton St., Milwaukee, Wis., $1325; Roth Bros., 1400 West Adams St., Chicago, Ill., $1763; Triumph Electric Co., South St., Cincinnati, Ohio, $1490; Westinghouse Electric and Manufacturing Co., $1271.

THE COAL MARKET

Boston—Current quotations per gross ton f.o.b. mines are as follows:

ANTHRACITE

	Circular Current		Circular Current
Buckwheat	$3.40	Boiler	$2.65
Rice	2.90	Barley	2.40

All-rail rate to Boston is $2.86.

BITUMINOUS

Bituminous, $8 to $8.75.

Pocahontas and New River, f.o.b. Boston, $8.35 to $8.90.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

	Circular	Individual		Circular	Individual
Pea	$5.50	$6.25	Broken	$6.75	$7.50
Buck	5.10	5.90	Egg	6.65	7.40
Rice	4.65	5.10	Stove	6.90	7.65
Barley	4.15	4.30	Chestnut	7.00	7.75

BITUMINOUS

Current quotations, gross tons, based on Government prices at the mines, net ton; f.o.b. Tidewater, at the lower ports, are as follows:

	Mine Gross	F.O.B. N.Y. Gross
Central Pennsylvania (Mine run, Prepared or Slack)	$3.30	$5.45
Upper Potomac, Cumberland & Piedmont Fields:		
Run of Mine	3.08	5.23
Prepared	3.36	5.51
Slack	2.80	4.95

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr Ago
Pea	$3.75	$5.00	$4.60	$4.00
Barley	2.40	1.90	3.30	2.15
Buckwheat	3.40	2.90	4.45	3.80
Rice	2.90	2.40	3.80	3.40
Boiler	2.70	2.20	3.70	3.80

Chicago—Steam coal prices f.o.b. mines:

	Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.55—2.70		$3.25—3.40
Mine-run	2.35—2.50		3.00—3.15
Screenings	2.05—2.20		2.75—2.90

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared Sizes	Slack or Screenings
Big Seam, Mary Lee, New Castle, Blue Creek, Brookdale, Milldale, Henry Ellen or Acmar	$2.45	$2.75	$2.40
Cahaba, Black Creek, Milldale, Carter and Durie seams, and Underwood seam in Etowah and Blount Counties, Jefferson seam in Marion, Walker and Winston Counties	3.45	3.75	3.10
Pratt, Brookwood, Nickel Plate, America, Jagger, Coal City, Jefferson (except in Walker, Marion and Winston Counties), Mt. Carmel seam or upper branch of Big Seam on Birmingham Mineral south of Bessemer	2.85	3.05	2.45
Helena and Harkness seams and coal mined by No. 2 Belle Helen, and Youngblood seam	2.90	3.20	2.70
Climax seam near Maylene, Shelby County	4.60	4.85	2.50